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EVIDENCE

BEFORE THE

MASSACHUSETTS COMMITTEE ON STREET RAILWAYS

AS TO THE

SAFETY OF OVERHEAD ELECTRIC WIRES.

FEBRUARY—MARCH,

1889.

MERCHANDISE
·POSTMASTER·
IF THIS PARCEL IS NOT TAKEN
FROM YOUR OFFICE, WE WILL FORWARD
STAMPS FOR ITS RETURN, IF YOU WILL
KINDLY INFORM US HOW MANY ARE
NEEDED.
THEODORE METCALF & CO.
39 TREMONT ST. BOSTON, MASS. U.S.A.

BOSTON:
R. H. BLODGETT, PRINTER,
39 BROMFIELD STREET.

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23 Aug. 1889
Gift of
Dr. Saml A. Green
of
Boston.

TESTIMONY OF ELIHU THOMSON.

Q. (By Mr. HYDE.) Will you state to the Committee whether the current that is used in street cars is dangerous to life? What progress has been made and what success may be expected of it in the future operation of street cars? Please state as fully as you can, in such form that the Committee will understand it.

A. The growth of electric railways has undoubtedly been very rapid of late, and as you have heard stated here, there are something like fifty roads in operation at the present time. The experience of those roads has dated back several years. Some of them, no doubt, were crudely arranged at first, but the whole matter is becoming rapidly systematized and taking very much better shape. In order to convey electricity any considerable distance it is necessary that we provide conductors to convey the current. We must also use a certain pressure on the current or the electricity will fail to be carried. In arc lighting this pressure rises to as high a point sometimes as 3,000 volts, and yet I have known men to come in contact with such wires, getting the full strength, and not be killed. There are a few other cases where people have met with fatal accidents by putting their hands on wires with a current of from 2000 to 3000 volts. By common consent, however, the electrical fraternity have dropped down to a voltage as low as 500 volts. That is the voltage which is now used on electric railways. The object of dropping the voltage is to get two things; that is, to secure safety and at the same time secure freedom from the tendency of the current to leave the wire, either on the car or anywhere else. The desire is, of course, to keep that pressure which will transmit the current over the line. We could operate the roads with 1500 to 2000 volts, but that is not feasible or advisable; we would find more difficulties in the construction of our motors. We are forced to keep the current down in pressure. A great deal has been said about the volume of the current existing on these lines. I say that that has nothing to do with it whatever. The volume of the current is nothing; it is merely the pressure which is to be taken into account; and this whole question hinges on whether 500 volts is a dangerous pressure or not. That is the whole thing, — whether 500 volts is a dangerous pressure or not. Now, it is a fact, as I am told, that the Western Union Company use on some of their lines in New

York City more than 400 volts; they use dynamos for working long lines. I have heard of various instances where the leakage in bad weather has been so strong that the instruments were overcharged and the operators could not even adjust their instruments with the pressure being as great as that. They use the dynamos to replace a certain number of battery cells. The number which they would replace of the Gove type, taken as an example, would be about 240 battery cells. It does not seem to them that that voltage has any particular danger in it.

Mr. Pope. They have used it for fifteen years.

Mr. Thomson. They have used it for fifteen years, as Mr. Pope says. They have substituted dynamos having a current of large capacity in place of their batteries, and still they find no difficulties with it. The pressure is not high enough to do any harm to the person. It is true that it is a pressure which will give a shock. Nobody denies that. Almost any pressure will give a shock, but the question here is whether it is capable of giving a fatal shock. I do not think any evidence has been produced here this morning which shows that it can produce a fatal shock, or has produced a fatal shock, which is the important point. There are fifty roads in operation. We are prepared to produce testimony in regard to persons who have come in contact with a current and have not been injured more than to get an electric shock. I have occasionally touched conductors of very much higher voltage than these. I at one time caught hold of a conductor having a voltage of 10,000 volts for a few moments. I got a very severe shock, but it did not kill me. On one occasion I caught hold of an alternating current of 1,000 volts, which you have spoken of as an exceedingly dangerous current, and that did not kill me. I do not say that I would voluntarily take hold of one of these conductors and take that shock, any more than I would go and have a tooth extracted without any reason for it. Bnt I do say that the escapes from serious injury from much higher voltages than 1,000 volts are frequent. The voltage which is now used on electric railways has been reduced to that which has been agreed upon as the practical pressure to use, involving safety and efficiency throughout the whole system. We could not do better than that; that is certain.

A good many points have been brought up here which it is hardly worth while to touch upon, but I am impressed with their contradictory character in many cases. Sometimes we hear of the impossibility of touching the wires and of the impossibility of firemen cutting the wires, because they are dangerous. We hear the statement made that firemen will receive shocks. All they have got to do is simply to have nippers with a wooden handle. They can cut any wire without any trouble. The wires can be cut very nicely by an ordinary pair of pliers without any danger whatever. I can say that there is not the slightest difficulty in removing all the wires in a very short time, if you choose, without any danger to people standing by.

Q. Take a trolley wire, what is the size of it right through?

A. It varies with the number of cars. It always has to be a heavy wire to carry the current. It is a very strong wire.

Q. I am speaking with reference to the difficulty of cutting it with a pair of shears with wooden handles?

A. There is no trouble at all. With a pair of cutting pliers wires can be cut very much thicker than that. With proper tools you can get a leverage that will do almost anything. Even if the wire were three-quarters of an inch thick it could be easily cut. It is not steel wire, it is copper wire.

Q. Supposing there is a fire and there is occasion to cut the wires and they are cut, what is the effect upon the operation of the road at other points?

A. The operation at other points is preserved. If the feeding lines for the current come in on two sides of a fire you can still run the cars. There is another point here. You can utilize this power in connection with electric fire engines. Supposing a steam fire engine should get out of fuel, you lose it, but with electric pumps you have a reliable power at the central station which will not fail you. That time will surely come, and when it does you will have an effect which will counterbalance the fire risks, which are being now exaggerated.

Q. In regard to the falling of other wires on the central conductor, is it the fault of the electric road wires if the other wires come down?

A. It is the fault of the wires that come down. Make your telephone wires strong and they will not come down as far as the electric road wires. Those wires ought to be supported better than they are and then they will not come down. They are flimsy; they are not properly supported. Support them as you would the electric road wire, which has to stand the jar of the trolley, and they will not come down. But the matter of other wires coming in contact with the conductors has always been brought up whenever a new system of wires has been introduced, and every system which has been introduced has been stronger than others, and the failure has been the failure of the lighter wires all through. The iron wires rust out and on the slightest provocation they drop down on the other wires; but danger from that can be easily obviated. Suppose you run out guard wires at short distances above the central wire, then if a wire drops down it will not sink to the car current line. Ground the heavy guard wire and have a line come down on it. If it touches the electric road wire it will burn the connecting link in a moment. There is no telephone wire in use which would not be burned out in an instant. If this safeguard cannot be provided you have still others, but simply grounding the upper wire—connecting it with the ground—suffices. Now, if the telephone wire sags from any cause, in almost all cases it will not probably touch the under wire at all, and in any case in which it does touch it will produce such a flow of current that the wire will simply break the connection, leaving you as before in extra good condition to carry your current to the cars. These are all precautions which can be adopted and are well known at the present time.

Q. As to persons riding on the cars, is there any danger either to persons who are riding in the cars or to their watches by the use of the overhead system?

A. The danger to persons is absolutely nill. The conductor comes up from the top of the car and is heavily insulated. That is necessary in order to have it stand moisture. It would give out at once if we did not have the circuit on the car thoroughly insulated, covered in as fully as possible, to prevent it from coming in contact with the car track itself. In fact, a car body is constructed of material which will not convey a current of 500 volts at all. As to the danger to watches, although I have not heard any complaints of any trouble of that kind, I should say that there might be some little effect on watches not made non-magnetical; but the great watch firms now-a-days are making watches which will get over that difficulty. In fact, it is being regarded as essential that a man must be equipped with a non-magnetic watch in these days of electrical growth. I have in my pocket a time-piece of that character, which I can put on a dynamo with the strongest possible magnetic field and it will not affect its running at all.

Q. Supposing a car runs in a thunder shower, what is the effect of that?

A. Well, the general experience has been that as the number of electric wires increase in a city there is less trouble from thunder storms. That is, there are so many points of escape for lightning discharges that very few places in cities are struck and injured during a thunder storm. In the country, in a suburban district, a wire of course might be struck, but look at the chances of its going to the ground! It is only insulated by a little porcelain knob from the side wires, which are often connected by a most complete circuit with the ground, and we also provide lightning arresters, putting them along the line as often as they may be needed, for carrying off any charge which could jump more than one-sixteenth of an inch. Lightning will jump a mile in many discharges. I would put a line of lightening arresters along the road which would carry off any current that can jump one-sixteenth of an inch, to the ground. Is not that sufficient protection? The fact is, if the lightning ever strikes a line it will find a number of points of escape and will not affect the car or go through the car; it will jump at once at the lightening arrester.

Q. As to the capacity of a car equipped with electricity in this way — to what extent is it capable of doing the business?

A. There is wonderful flexibility in the system. The motors, when properly constructed, can be run up to a very much higher point than their normal, ordinary capacity; so much so, that I have known instances of an electric car pulling two other cars loaded, and on an up-grade at that. So that under stress we have everything that we want. The power goes to that portion of the line which needs the power, and to the lighter loaded portions in proportion to the reduced load. That depends altogether on the amount of current which flows through the motor under any given conditions, and that amount of current is under control, varying with the speed of running. A little slower speed makes the current larger, makes the car capable of pulling a little heavier load.

Q. (By Mr. Ries.) I would like to ask Prof. Thomson whether the use of the small size wires to which he has referred would not require a current higher than 500 volts?

A. That is a technical question which calls for expert information. I am quite willing to give it. I would in all cases run feeder lines and conductors altogether independent of the main line. You may run any number of cars, a thousand cars, if you please, under that system. You can put a feeder line under ground; the potential is not so high but that you can easily handle the underground freeders. There is no question that you can put a feeder underground. Of course we can run a million cars with 500 volts under that system.

Q. From one generating station?

A. From one generating station.

Q. Could you do that in the same way that you handle it on the West End?

A. No, sir, I don't say so. I say that as your power runs up you would have to add an additional feeder line and you would work by a central power station one or more. The car companies will settle that. They will say: "If we want a power station here, we will put it here; if we want a power station there, we will put it there."

Q. How many amperes will you carry on the wires to which you refer, those wires that you can cut with shears?

A: Up to the maximum.

Q. What is that maximum?

A. The maximum is that which never heats a wire, produces not the slightest effect upon it.

Q. How many amperes?

A. The experience of some roads is that it takes eight or nine horse-power to a car. That can be figured out very easily. You can do that.

Q. What I want is a rough statement as to the number of cars you can supply from the ordinary overhead wire which you can cut conveniently with the shears?

A. By putting your feeder wires anywhere you please you can supply any number of cars.

Q. Would it not be necessary to run a very large spiral and more conductors and feed wire?

A. That is a question for the companies. If they are willing to put in copper wire, why need you complain?

Q The question is, if you were to operate a system of street railway cars, such as are run in the streets of this city, with overhead conductors, pure and simple, without any underground feeders, would you not have to use copper wires which would be inconvenient to cut and which would require poles to support them?

A. I don't think you would. It would depend upon the condition of the power station altogether.

Q. If you had one power station?

A. I am not dealing with things which are not in accordance with good practice. I am dealing with good practice in all cases.

Boston, Wednesday, Feb. 27, 1889.

The hearing was resumed at 10.15.

TESTIMONY OF PROF. ELIHU THOMPSON, resumed.

Q. (By Mr. Ries.) Prof. Thompson, I want to ask whether it is possible to receive a shock from an electric circuit carrying a force of 500 volts if the contact were made directly with both conductors, and whether such a shock would not severely injure a man, woman, or child, who received it?

A. I think it is possible. I said undoubtedly it is possible to receive a shock, but I said the limit of voltage had been placed so low that the shock would not produce a serious injury.

Q. In other words, 500 volts would not produce a serious shock.

A. I think there is plenty of testimony that persons have taken the shock, and they will tell all about that matter. I have had much higher shocks than that, very much higher, as I said before, and without injury.

Q. Would you be willing to place yourself in the circuit with a dynamo current of 500 volts in such a manner that you would be in contact with the circuit when it was broken?

A. I don't know that that has anything to do with the matter.

Q. If the contact were made with the telegraph wire and with the overhead wire, and a little boy were to run and pick it up and break the circuit, he would be liable to receive a shock?

A. How could he break the circuit?

Q. By taking and separating the telegraph wire.

A. I should say the boy, by doing so, would simply relieve himself from the shock without getting the slightest additional harm. I would explain that matter in this way, gentlemen, — that Mr. Ries evidently is confusing two things. He is confusing what we call the matter of extra discharge of a line with the breaking of a circuit. Now it requires a long line of considerable volume to get up a kick, and the boy's resistance amounts to this, it is so high that a current which would pass through his body amounts to nothing, and breaking that circuit couldn't possibly do anything but stop the shock or rectify the effect of making the circuit. To use an illustration, take the case of simply shutting off water in a pipe very suddenly. Every one of you probably is familiar with the action that takes place if you quickly shut off water in a pipe. If there is a long line of pipe and a considerable flow of water, there is a kick in the pipe. So, when the telegraph wire falls down on the overhead wire there might be a slight shock. Mr. Ries is evidently confusing a case of that kind with a case of breaking a circuit.

Q. If you take a circuit that is closed for the time being and turn a current of 500 volts on so he could take the shock —

A. How many amperes would the boy carry at 500 volts?

Q. Suppose you take a simple circuit carrying 500 volts, and having a dynamo capable of generating a sufficient current, if the circuit was broken while the two ends of the circuit were in contact, wouldn't the boy holding those wires receive a shock that need not necessarily prove fatal, a shock to his nervous system?

A. I don't see how that circuit could be broken.

Q. Well, a person would receive a shock if it was broken?

A. I dont't see how that circuit could be made. In the first place, to get the conditions you will have to make a diagram of that arrangement before I can understand what you are driving at.

Q. You spoke yesterday in regard to taking a current of 10,000 volts without injury?

A. Yes, sir, alternating.

Q. Was that current produced by the dynamo or transformer?

A. Transformer.

Q. Can you state the volume of the current that was passing at the time?

A. The volume of the current that passed through me was a fraction of an ampere, probably 1-10 of an ampere.

Q. If you took hold of the two opposite conductors of the parallel system would you not receive a sufficient amount of current through you to give you a distinct shock? That is to say: the current you would then receive, 500 volts, would be much greater than if you had received a tenth that you have alluded to?

A. Not at all. The resistance of the body, measured from hand to hand, varies from 2000 to 4000, and even higher ohms. 500 volts would give you a very small current over that resistance, and then it would not be an alternating current, which has more physiological effect than a continuous current of the same volume.

Q. But suppose you make a circuit, and stand holding the ends?

A. You break the circuit in that case, and get a shock.

Q. Wouldn't you, under those conditions, get sufficient shock to make it injurious to the person receiving it?

A. That comes back to the broad question again. I say that the boy standing on the ground and touching the overhead wire, 500 voltage is not enough to give him a fatal shock. The current will not pass through the body, because the current is too high for that pressure. These conditions must be definitely stated in order that I may answer exactly, or say anything more definite than that. You have asked about a boy standing on the ground touching the overhead wire and telegraph wire, in which case he might get 500 volts, in case his shoes didn't give any resistance. I say that, on account of the high resistance of his body preventing the current passing through to any amount, he would not be injured. The breaking of that circuit through the boy is like the breaking of a stream of water in an exceedingly small pipe with no length of flow back of it. It takes many hundreds of feet to get up what we call an electrical kick.

Q. We understand the resistance of the human body is much greater than that of the motor, but, on the other hand, it takes a much smaller current to have a physiological effect, that is, than on the motor. The question is, wouldn't that small amount of current be sufficient to produce this injury?

A. I said at the last hearing that a current of 500 volts is not too high for safety, is not a high voltage, and it is not capable of passing a large current through the system which would produce a detrimental or fatal effect, or produce paralysis. My experience is that it is not so, that is, if you double it, or treble it, or quadruple it, there are cases where a man is not injured at all by receiving a quadruple effect, but there are cases where fatal effects have been produced with very high voltages. If Mr. Ries means are there any cases where this 500 volts did produce those effects, I should say there are none.

Q. You don't think it would be possible to produce fatal effects on the human body with 500 volts under any conditions?

A. Perhaps, if you put a sponge on one side of the head and a sponge on the other, or one at the middle of the back, and pass a current by them, and another at the head, you might.

Q. If the resistance of the subject was sufficient, you might cause him to receive an injury?

A. If it was made sufficiently low by the proper appliances he might get an injury. We have no cases known to us.

Q. Does it not happpen in some cases that lightning flies along the overhead conductor and is grounded without passing through the lightning arrestor?

A. I should say some would pass through the motors. and in other cases the trolley wires would act as a first-class lightning rod to any person in the car. It would follow the conductor, which is able to carry an enormous current, and would go to the ground without entering the car at all. In other words, a man on a locomotive, with metal around him, carrying a circuit from the top of the cab to one below, is not going to be struck with lightning at any time, and that is the condition in all these cases.

Q. In case of a very heavy lightning discharge, wouldn't it fuse the motor wires?

A. I don't think it would. It would simply jump when it got near the ground. Lightning doesn't have time to fuse that motor wire. It jumps to the ground when it is near the ground. It passes through the circuit of least resistance — the least inductive resistance, not the least electrical resistance. In other words, I must explain that a little further. Lightning acts differently from the ordinary electrical current. The lightning is discharged with great suddenness. Now if I try to make it pass through a coil of wire, it will jump across a space in the air rather than go through that coil of wire, which would be 700 or 800 feet in length; it would rather jump this space in the air and go to the ground that way. Suppose it comes down from the overhead wire, and finds the coils of the motor altogether too long for it, it would take the next nearest iron post, the next nearest metal post, which is only probably a quarter of an inch away at any point, and will go to the track that way. In other words, it will shunt the motor, and we put on devices for that very purpose to prevent injury to the motor. We put on a little jumping space, so that the lightning can jump that space and not damage the motor, because it may tear through some part of the insulated motor, and we therefore make a point for it to reach the ground easily.

Q. Will you please explain how that 10,000 volt current was taken by you?

A. It was taken from an alternating machine working the primary of an induction coil, and the secondary of the induction coil was taken into my hands by accident, and I got the full strength. The probable reason I survived was that I jumped away quickly. I said, "Here, you jump out of this, or you are dead." I knew 10,000 volts would kill me. It was capable of leaping from one wire to another, and at a distance of three-eighths of an inch, and without first contacting them. I got hold of the wires, and took the current in my body. The volume I had at that time, I was satisfied, was sufficient to kill me. But there was an enormous pressure, 10,000 volts; it had the power to jump through the air, and I got the full effect turned both ways. It went through me both ways fifty times a second, this way and that way, and the only effect I felt was that my arms were numb when I got away.

Q. What would have been the effect had the current been 50 or 100 amperes?

A. I never heard of a case of 50 or 100 amperes passing through a man.

Q. Not with 10,000 volts?

A. No; I never heard of such a case, and I believe the man would be instantly vaporized. I think he would disappear in smoke. Ten thousand volts wouldn't do that, Mr. Ries. It would require a good deal more than 10,000 volts. It would require a lightning discharge to do that. You probably have heard of cases where men have been struck with lightning where they have been found considerably burnt by a very heavy lightning discharge passing directly through them, an amount made up of so much horse-power so that it practically disorganizes and vaporizes the whole structure. A tree may be struck by lightning and every particle of moisture in it may be vaporized in an instant, and the tree be exploded in every direction, but I never knew of a case of that kind in a man. We are getting beyond any ordinary voltage produced by any apparatus at our disposal that could produce an effect like that.

Q. You said at the last hearing that, in order to prevent accident from overhead, it would be necessary to guard against contact. Do I understand that, in order to prevent that, that all telephone wires must be strengthened that pass over railway conductors?

A. No, sir; I did not say that. I said it is sufficient to run a guard wire over the overhead line, and, in case the telephone and telegraph wires did come down, the guard wire would catch them.

Q. But without the guard wire it would be necessary to strengthen it.

A. I didn't say it was necessary. I should think if it came down you might have a little risk of diversion, as if telephone lines cross the telegraph wires at high power; that is, a current would flow which would probably burn out the coils of the telephone.

Q. If a telephone wire came across your overhead conductor, what would be the effect of a current passing through the telephone line? Wouldn't it burn it out?

A. It might.

Q. And if a person were using it at the time he might feel the effects of it.

A. I don't think he would; oh, no.

Q. If he placed himself in connection with the circuit?

A. I think not. He would have to fulfil such conditions; he would have to be in the circuit, to take hold of two wires of a circuit. To put a telephone to your ear you take hold of the hard rubber, and if you take hold of one wire you are not in the circuit.

Q. It would fuse the coils of the instrument, and might produce fire?

A. It might if there were no safeguards used. It would only be necessary to put a fuse wire in the circuit.

Q. (By MR. BRACKEN.) When you said you received 10,000 volts at Lynn, or wherever it was, you didn't say what the current was.

A. I didn't measure the current. I know the voltage was high enough to send a considerable current through me, as it was sufficient to work a light.

Q. What is the lowest unit known to us in electric current?

A. The ampere, or there is a one-thousandth of that.

Q. Then you said you took about one-half of an ampere?

A. It may have been more or less.

Q. The one-tenth of an ampere?

A. It might have been one-tenth or one-half.

Q. In other words, water was being pressed through a pin-hole. That is the current you took when you took the 10,000 volt shock?

A. I don't think you get the point at all. Perhaps I was the pin-hole; that is, my resistance was so high the copper wire of the coil afforded easier resistance than I did.

Q. There was a pressure of 10,000 volts, you claim?

A. Yes, sir.

Q. Pressing water or a current through a pin-hole; that is, the one-tenth of an ampere. I give that as an illustration. You claim to have received 10,000 volts pressure, but you took good care to keep in your mind, and not state to the Committee, that you did not receive only one-tenth of an ampere?

A. I don't know how much I received. It might have been more or less, according to my resistance at the time. Now, Mr. Bracken, about the pin-hole. If that is the substance of the illustration, I would like to be informed where you consider that pin-hole existed?

Q. I am asking you questions. I don't want to befog the minds of the hearers. When you were using technical terms about lightning, you could go into explanations that carry no meaning as to the point in question. You stood up here and boasted that you received

10,000 volt current. You didn't say it was only the one-tenth of an ampere.

A. That is the first time any of my explanations have been received in that way.

Q. Well, we always have to make a beginning in something.

A. My endeavor is to make things clear as possible.

Q. You didn't say it was a very small current, did you?

A. I said I knew nothing about the current. It might be the one-tenth of an ampere or one-half an ampere.

Q. How many amperes are you sending over your wire between here and Cambridge to carry those cars along?

A. It varies anywhere from about no amperes up to 180.

Q. You also said that the Western Union Company were using dynamos of 400 volts potential in New York City, for the purpose of sending currents over the telegraph wires, yet you did not say what current was going through the wire. Will you state now?

A. The current depends on where the contact is made with the power. If near the Western Union office it has the full power of that dynamo. It may be anything, as one and a half or less. The volume is only limited by the power back of the dynamo. It might be easily raised forty times.

Q. How much would that be?

A. Say forty amperes. I have known instruments to be burned out by the current the moment the wire has been crossed to ground.

Q. Do you mean to tell these gentlemen that forty amperes pass through a telegraph wire used by the Western Union Company?

A. It could.

Q. But does it?

A. It would on a short circuit.

Q Have you ever known it?

A. I don't know that I have.

Q. Have you ever read in literature that it has? Have you ever read such a thing as that?

A. We don't need to read such things as that. That very small current is the normal working current for telegraph work. Mr. Bracken is evidently trying to create more confusion, and not I, because he is trying to have it inferred that the current is limited to this fraction of an ampere. I say that the pressure determines the current with the resistance in the circuit. Now, if your resistance falls off, as it may here, your pressure is high enough to send a large current. It is exactly the case of the water in the pipe again. If you have got a pressure on there, and you suddenly open a large aperture for the flow, you will get the flow. Now, Mr. Bracken assumes that the conditions are preserved when the crossing is on the line, and I say they are not preserved; a large amount of current may be diverted through the new contact. The whole question is one of pressure over resistance. The current which flows at any time equals the pressure, or the electro-motive force, divided by the resistance; 500 potential means 500 units of pressure. Now, in a man's body the resistance is always high. The dynamo telegraph is worked by the same pressure, and a large number of lines may radiate from the dynamo. It is expected that the generated current is just about the same on each line from the dynamo; they feed that line, and that line and others, all from one dynamo. They send out there an ampere, there an ampere, there an ampere, and there may be a large number of lines in operation from that one dynamo. The current is not this small current that goes over a single telegraph line. Now, I say, take a telegraph line leading from that dynamo, leading into the city, and you can get a current diverted from that line which amounts to a considerable number of amperes. But that is not the point. The point is, what would that telegraph current pressure send over a human body. It don't do to confuse the matter by talking about increasing the amperes.

Q. How much can you increase the amperes?

A. If the resistance of the human body equals the telegraph instruments along the whole line, you will get the whole current that you would on the telegraph line. If it is greater than the resistance of all those instruments on the line, you will get less, the resistance of the body always being higher than the telegraph line.

Q. You say 450 volt dynamo gives the same shock running on the telegraph line as by running your overhead line. At what point? Do you mean to say if you come in contact with the wires going over the city you receive the same shock as from your wires?

A. If you stood on the ground and took hold of those telegraph wires at 450 volts you would get the current at 450, which could pass through the resistance of your body, but you would be worse off on the telegraph line.

Q. How much current would you get?

A. The average resistance of the body equals 3,000 or 4,000 ohms — 500 volts divided by this resistance of the body — 1-8 or 1-10 of an ampere.

Q. Suppose the current was 150 amperes and you stood on the damp ground, what would the effect be?

A. You could not get that amount through a man. You deny all the electrical laws.

Q. Will you take such a current at 500 volts?

A. I think it would be just as sensible to make me drink the water that comes out of a four-foot water-main.

Q. Will you take 150 amperes standing on the ground, coming from a 500 volt battery?

A. Let me say, gentlemen,—

Q. Will you take 500 amperes, or 150—

Q. It will do you no good, before these gentlemen, to answer the question by evading it. I asked whether you would take 150 amperes with 500 volt potential?

A. That is a poser, I must say. No mechanic would ever ask such a question, or an electrician.

Q. Will you answer, yes or no?

A. I will say that it is absolutely impossible to conceive of such a thing.

Q. You admit you send it over your conductor?

A. Oh, I sent it over a clean, copper wire, which is a million times a better conductor.

Q. Suppose I make it possible for you to take it, will you do it?

A. You will have to make a discovery, Mr. Bracken. You pass 150 amperes through 4,000 ohms, at a pressure of 500 volts — you will discover perpetual motion by that time.

Q. Will you take it?

A. I say I can't conceive of the possibility, Mr. Bracken. There isn't any such thing as passing, at 500 volts pressure, 150 amperes through one.

Mr. BRACKEN. If you can afford to leave off here, Professor, I can.

Prof. THOMPSON. If Mr. Bracken will discover that method of passing 150 amperes at a pressure of 500 volts over the normal resistance of the human body, I say I will take it.

Q. (By Mr. RIES.) Would a current of ten amperes passing through the human body be fatal, if you had pressure enough to pass it through?

A. I think that depends altogether on where it passes. There are plenty of cases, I think, where men have short-circuited through portions of their body current equal to ten amperes for a short time.

Re-direct.

Q. (By Mr. Griffin.) When a dynamo is on the overhead line and there are no cars running, is there any current in the overhead line?

A. No, sir.

Q. When one car moves out does that car take 180 amperes?

A. No, sir. It takes just whatever current is necessary to propel the car, which may be more or less according to the grade it is on, and that current only goes into the car, that is, — the line is aided to convey the current through the resistance which the car opposes, which is made as low as possible to get a large current there. The car is not a human system at all. It is organized with copper-wire and other good conductors, and the current passes through a copper-wire and makes the movable copper-wire turn. That constitutes the motor, and being made of copper-wire, it is a million times better conductor than the human system, and it may receive ten or fifteen amperes.

Q. In other words, before any car is put on the line, the circuit is not closed till this car comes in and closes the circuit between the overhead wire and rail?

A. Yes, sir.

Q. That car takes just what current of that which is called 500 potential as will drive through the resistance of that car?

A. Yes, sir.

Q. When you put another car on, that car takes a similar amount?

A. Yes, it takes more because it has to do more work.

Q. As you increase the number of cars, by and by you get enough on to take 150 or 180 amperes. Now, where that ampere current is running on the overhead line, does that current run through each car?

A. No, sir.

Q. If you put a man in there, does that 180 amperes go through that man?

A. No, sir.

Q. If you put any kind of connection in there, the number of amperes that goes through that connection depends entirely upon the resistance, does it not?

A. The resistance of the conductor which would carry the 180 amperes has to be equal to the resistance of so many cars all put in parallel, *i. e.* — their combined resistance diminishes with each addition. In order to send 180 amperes from the wire you have got to get as good a connection as all those cars working like parallel-pipes would give, or, in other words, you have got to so lower the resistance that you reach the combined resistance of maybe half a dozen or more cars. The combined resistance in a case like that is just the fraction. Suppose one car has twelve units resistance, then the combined resistance of twelve cars would be one unit, because they are laid off this way, side by side, and in that condition 180 amperes might flow. Now you have got to get only such units of resistance between the overhead wire and the ground to give that condition, or the current equals pressure divided by the resistance.

Q. Now, we will suppose a man is to take a shock when the car is half a mile away. You say the current which he would take would depend upon the resistance of his body?

A. Yes, sir.

Q. In other words, it is altogether fixed by mathematical law. Now suppose the number of cars is such that forty amperes will drive them, and only forty amperes are passing over the line, will that make any difference in the amount passing through that man?

A. No, sir.

Q. Suppose it is 100?

A. Not a particle of difference.

Q. Suppose it is 180?

A. No, sir.

Q. In other words, the shock that passes through him depends absolutely on his resistance and not on the number of amperes that may be going through, passing off in another section?

A. Not at all. On the latter condition.

Q. (By the COMMITTEE.) Do you get 150 amperes over the copper wire?

A. Yes. The copper wire is just like a pipe. Now to give you an instance of what amperes really mean, I can say that we are making in Lynn a welding apparatus in which are currents of 50,000 amperes, and yet you can put your tongue between the two conductors that are feeding that 50,000 amperes, and not feel it — not know it. You can grasp the metal bars that are being welded by 50,000 amperes. Why? Because the current has nothing to do with the pressure, except as resistance is considered in the case. We put our bars together and get a resistance practically so low that a very little pressure will send a whole river of current through them, because of their low resistance. When the resistance is high, then, of course, it requires a higher and higher pressure to bring a given current through it.

Q. Suppose you were running your cars on an overhead wire with a 500 volt attached, would it make any difference if a person came in contact with the wire?

A. Not at all. It regulates itself at the station. It doesn't make any difference. It regulates itself the same way the water system regulates itself. You turn on the water here, and the water flows, but the pressure is altogether independent of that. If there is resistance in the pipe and you increase the flow, you get a little less pressure at your delivery point.

Q. (By Mr. ABBOTT.) Do I understand you to say you are going to show the Committee experiments on your line out there? Let them see some man receive these shocks?

A. I said we have plently of cases where men have received these shocks. I don't know as I really advocate the pulling of teeth, unless the teeth are necessary to be pulled. I don't regard pulling teeth as a fatal operation by any means.

Q. I only want to ask you whether you are going to make the experiment out there. It is a simple matter to do, isn't it?

A. If we get a subject.

Q. You think it is about as bad as pulling teeth to take these shocks?

A. It is a painful operation, no doubt.

Q. Is there any objection to subjecting the public to having their teeth pulled?

A. I don't think the public will be subject to that.

Q. If a wire is down will you let your men form what they call a second ground?

A. I should say this, that our men would in that case pick up the wire.

Q. Would you like to have them try it, throw it down and experiment with it?

A. I don't know that an experiment is necessary to be made.

Q. Would you like to have the experiment done in the presence of the Committee?

A. I should like to.

Q. Why won't you have it done?

A. If we can find a subject.

Q. What happened to your car at Cambridge a few days ago? I saw by the paper you had some trouble about it?

A. I haven't heard anything about it.

Q. If an accident of the kind I refer to should happen, it would indicate there was a very hot current, wouldn't it?

A. All currents are equally hot as far as I know. It depends altogether on the resistance they flow over and the volume of the current.

Q. The more the resistance the greater the heat difference ?

A. No, not at all. Take for example our welding operation. If I take hold of that machine I put in a resistance which doesn't give any heat. Why ? Because I must have a sufficiently low resistance to allow a current to pass over that resistance which will produce any particular heat.

Q. Will your 500-volt wire send a current through a man ?

A. A slight current.

Q. It will overcome that resistance ?

A. On the same principle that any electric current will go over any resistance.

Q. You have pressure and resistance ?

A. Yes, sir.

Q. You have some current ?

A. You have some current, but no current to produce any effect.

Q. You have 180 amperes. That is some current is it not? You get all the current you can get through a man ?

A. That doesn't go through the man.

Q. Isn't it a fact that a man standing under Niagara Falls, although he does not take all Niagara Falls, he gets enough to make him feel unpleasantly ?

A. On the same principle, Niagara Falls would be better compared—

Q. It is pretty fatal to a man, although he can't take the whole current ?

A. That is not the case at all.

Q. Have you ever heard of animals being hurt by—I don't know whether it is your system—down in Richmond ?

A. It is not. I believe it is the Sprague system.

Q. Have you heard of any instance down there of animals being hurt ?

A. I know of no case where there is testimony to show that animals have been hurt.

Q. If you had the testimony of the man in charge that animals were hurt, would it affect your opinion ?

A. I should weigh the evidence in this way : an animal will, even under a slight shock, often do itself great injury by kicking and tangling up the wire.

Q. It doesn't know when to let go, as you did?

A. Not exactly that; no. A horse will be frightened, for example, or any other animal would be frightened—

Q. If a little boy gets a grasp on your wire will he let go in a hurry?

A. My experience with boys, they are not very easily frightened.

Q. I heard of a lady, who, at Cambridge, caught her skirt in your wire, and attempted to take it out. There was a case where she got pretty badly burned, didn't she?

A. I don't know about that.

Q. If the testimony satisfied the Committee that down on one of your overhead railways in Richmond a shock had been received by a horse and a mule, enough to kill the two, and was satisfied of the testimony, would that alter your opinion as to the dangers of the overhead system?

A. That would not alter my opinion.

Q. Then your opinion is not capable of alteration?

A. It is, on sufficient evidence.

Q. I say, if you were satisfied — I am utterly ignorant as to the facts of the amperes and voltage and all that sort of thing — all that I claim is that your overhead system resulted in killing a horse and a mule. Now, given that state of facts, would or would not it change your conviction as to the fatal or injurious effects of the overhead system of direction?

Mr. CUMMINGS. You mean on the human body?

Prof. THOMSON. That is the point, of course, which would not change my opinion in relation to the effects on the human body. I should have the mass of testimony on the other side.

Q. What is the difference in the resistance of the human body and the horse?

A. I don't know as it has ever been measured.

Q. Did you ever read or investigate at all the experiments that were made in New York in regard to the effects of electricity?

A. I have read some.

Q. Don't you know they tested the resistance of animals very carefully?

A. They did.

Q. Are those experiments of any importance in your mind?

A. Not in the case in question. The resistance was tested under conditions — the idea being to find those conditions on which the most current could be passed through a system, and they made conditions as favorable as possible; artificial conditions introduced for a definite purpose.

Q. They have no tendency to enlighten your mind on the subject?

A. As far as the resistance under those conditions, they do enlighten.

Q. Is a horse or mule more exposed to the dangers of electricity than a man?

A. It would seem so. So far as my experience goes, man seems to have been toughened by his continual warfare.

Q. (By a COMMITTEE.) Won't a horse take a more severe shock, on account of his shoes, than a man?

A. Without doubt, and his body is larger, too, and it may be his blood is full of salt, more saline than man's blood.

Q. (By Mr. ABBOTT.) Take the whole subject at large, would it have any effect on your opinion to find that your lines would kill a horse in the street, if he were touched by the current?

A. I should say that just on that matter it would settle in my mind, if the conditions were such that the current could be shown to have done the damage, it would settle in my mind that a horse might be killed.

Q. It would settle it in your mind if you found the wire attached to the horse, and the horse dead — would you say it came from the telegraph wire, or would you say it came from your machine?

A. I should want to determine in the first place that there was no other contact on that line at all, that there was no higher pressure of current came on that line; and in the next place I should want to determine just how the current got into the horse, whether the surface of contact was large enough to —

Q. It might be interesting to you, but how about the poor horse, or any man? It would not interest him much to find out how it got through!

A. That is just the point under consideration.

Q. The question that affects this Committee is not how many ohms or how much resistance there is in a man's body, or how many volts you send from your machine, or amperes. The question is, will that current which you send over your wire kill people in the street, or give them bad shocks, or little shocks, like pulling teeth out? Enlighten us on that subject.

A. That is what I have been trying to do. I have stated my opinion as clearly as I know how. I see no reasons for changing that opinion, and I don't expect to change it.

Q. Then nothing would change your opinion?

A. Oh, not at all. I am willing to change for reason.

Q. I understand you to say that the volume isn't of much account so far as danger is concerned?

A. That is very true.

Q. It don't make much difference whether you are exposed to an eighty-ampere current or one-ampere current, if the pressure is sufficient?

A. That is true. The amphere current depends on the resistance to the pressure. You can't expose a man to an eighty-ampere current. If the current that struck me was eighty-ampere, at 500 volts, I would have got the same shock exactly.

Q. Are people ever killed by electricity?

A. Yes, sir.

Q. What is the safety line in electricity?

A. I think the majority of cases show that it is over 1,000 volts. Most fatal accidents occurring with electric light lines occur when the pressure has been about 2500 or 3000 volts.

Q. In order to operate carefully you have got to have either a large voltage on a small wire, or a lower voltage on a large conductor?

A. Yes, sir.

Q. Practically, could you operate on a long circuit, fifty cars for instance, economically at a time?

A. How long a circuit?

Q. At 500 volts.

A. Oh, yes, sir.

Q. On a circuit of ten miles, five out and five return?

A. I think in the case of a circuit that length, by placing a power station at each end of the line, you would have perfect success.

Q. Now, what you proposed the other day was, to have a main line running under the street feeding these lines?

A. Yes, sir.

Q. You could put a large conductor under ground which would feed at different points?

A. Feed at different points the car line.

Q. That would be running at 500 volts?

A. At the same pressure, yes, sir.

Q. That would be considerable difficulty, wouldn't it, to put that pipe down?

A. I see none whatever.

Q. If it is not difficult to run an expensive and large conductor under ground, why don't you run your railroad by the same thing, and not bother us by the dangers of an overhead line?

A. The answer to that is, in order to get your current into your car, you have got to have access to the current all along the line.

Q. You have got a conduit system, haven't you?

A. No, sir.

Q. It works, doesn't it?

A. No, sir; it does not.

Q. When does it stop working?

A. When a little slush comes.

Q. And the slush came a little before this Committee began to sit? It stopped two days before the introduction of this bill, didn't it?

A. I would say I have not any familiarity with the running of this system; in fact, it is not our system. It was not a success, and I can well see the reason for it. I predicted it would not be a success under the conditions in Boston. The conductors are to too exposed to slush and mud in the streets. The leakage must be a source of trouble, and I predicted it when they were putting it down.

Q. It is a question of expense, isn't it?

A. I don't think it is. The gentlemen here can probably tell.

Q. They do run them, don't they?

A. They run them occasionally; yes, sir; in good weather, absolutely dry weather, there isn't much trouble — ought not to be, at least.

Q. It is merely a question of expense between the overhead or the underground system!

A. I think not. It is a question of working — feasibility.

Q. Have you given that subject enough attention to ask the Commonwealth to injure and ruin people's property, to change their law, to endanger life, for this purpose? Have you given that consideration enough to ask the Commonwealth to do that at this time, when you haven't tested your conduit for five or six months? Do you think in your mind the necessity is great enough to ask the people to undergo all those troubles and exposures?

A. I have had a great deal of experience with electrical appliances, and my answer to that question would be, I know of no conduit system to-day anywhere which I would trust. I should expect constant trouble. I will most heartily welcome any practical system of conduit which will do the work successfully, and I would say the overhead line in that case could be readily removed, and without much sacrifice in the removal, if it ever comes. I don't know anything about that. The difficulties are great, and methods of overcoming them are not developed. We don't know anything about what the future of such a system is.

Q. (By Mr. Ries.) Do you deny the possibility of making a conduit which would operate successfully under those conditions?

A. I don't deny the possibility of developing almost anything mechanically. I have had too much experience in that particular line to make any such denial. I would say perpetual motion is about the only thing I don't regard as feasible, but I think a machine could be made to read a paper or do anything of the kind; but it is a question of whether it will do it right along when it is complicated; it may do it in fair weather when everything is all right, but there may come wet and storm, and stop the operation. Those are matters which pertain to the future. It demands a good deal of work, and when it will come nobody knows, but when it does come it is a very simple matter to introduce. If storage batteries are things to be used for propelling cars, I suppose by and by there will be plenty of field for them, and I hope the time will come when all these different lines will have their own field, and I would undoubtedly prefer a practical conduit for city work, if it could be got.

Q. You think, then, a conduit would be preferable to the overhead system?

A. Yes, sir. I am not in love with the overhead system; but I say, are you to solve this problem of getting people about in time? There must be something done, and we can do it, and do it without introducing any hazard.

Q. The greatest objection seems to be that there are good enough conduit systems and other methods of railway being developed which will be put in operation perhaps in six months or a year, and, in that case, it would be folly to equip a city like this with overhead conductors when the proper method would be available.

A. The conduit system has not been tested so thoroughly as the overhead system has. The conduit and overhead systems have come into use about the same time; they are simultaneous, and a great deal of money and experiment has been spent in developing the conduit system, and thus far the overhead system has proved to be the practical method.

Q. Do you admit, if means were provided for obviating these stoppages by dirt and so forth, that the conduit system would be preferable to the overhead?

A. I would say that a conduit system would be preferable when made thoroughly practicable. It is a difference of opinion whether there are any in existence. I understand Mr. Ries is interested in some conduit system, and he would naturally feel a little inclined towards favoring the view that this ought to be held off until "we could get a chance to see what we can do." But that is a question which decides itself, just as soon as the practical plan comes. Why isn't it going to be a thing that everybody wants?

ONE OF THE COMMITTEE. Everybody couldn't afford it.

PROF. THOMSON. As to expense, I think the overhead system will hold its own out of town, because it would not be possible to lay down a conduit system and make it pay, and run a car over it every half an hour. Look at the interest on capital buried in the earth, and the fact that you cannot exercise any supervision over it. You can't tell what might happen to it. The conduit running out five or six miles in the country is a very different thing from any overhead line running out into the country, and I say there is little question that the overhead line will hold its own for that kind of work, but I would myself freely welcome any kind of conduit system which could be put down in Boston and do the work.

Q. Suppose the Legislature should pass some restrictive measure requiring your line to go underground. Would that mean practically the defeat of your road at Cambridge?

A. It would defeat the enterprise and deprive them of that locomotion.

Q. (By MR. ABBOTT.) Do you think it fair that the city of Boston should be exposed to the danger of fires to enable the Cambridge people to get in? Isn't that a little unfair to the 450,000 people here?

A. In the first place, I don't admit the exposure; and next, I think it is for the city of Boston to decide.

Q. (By MR. RIES.) The opinion you have just given as to conduits, that you think it would block the whole enterprise, is based upon what experience you have had?

A. From what I have known and seen of conduits.

Q. But not upon what has not yet come to your knowledge, of course. You simply say that according to the present state of your knowledge—

A. I don't deny possibility; but I say here is a thing which can be worked, and here is a thing of which we do not know anything, and experiments thus far have not proved the thing is desirable or will do the work. The question is, are we going to wait five or ten years, or three years, for something which we do not know whether it is coming or not?

Q (By ONE OF THE COMMITTEE.) What is the difference in cost?

A. The difference in cost is considerable. The overhead line — the voltage depends on how the work is done — the overhead line can be put in now for $2,000 or $3,000 a mile.

Q. And the conduit?

A. I have no data on the conduit. I can say this without doubt, that the conduit system, if we are to have all these safeguards and all these practical workings, it must come within a reasonable sum, or the cost will be prohibitive. It won't do to put fine clock machinery in the conduit — to build a conduit which will cost many, many thousands, liable to be superseded by something better. It has got to be carried out on practically the best principles.

Q. Wouldn't it be practicable to use horses in the city limits and use the electric overhead wire?

A. The very fact of the presence of the horses on the streets deprives the road of so much carrying capacity. You cannot pull so many cars, and there is the length of the horses sandwiched in, which is practically so much dead room, and you can put in more cars and make better time without the horses.

Q. Isn't there also a difference as to the weight you can pull?

A. The electric car, having motors attached, requires more power to pull it. It is just like loading up your car with your horses, and putting on other horses to pull them. Each motor weighs about 1,700 pounds.

Q. (By Mr. RIES.) You say it costs $2000 to $3000 to lay the overhead wire?

A. It may. It depends on the number of cars you run.

Q. Do you know Mr. Mansfield, connected with your company?

A. Yes, sir.

Q. Was he connected in February, 1888?

A. Yes, sir.

Q. Have you read the paper which appears in the Electric Motor?

A. I don't think I have.

Q. How many horse-power would it require to run a hundred cars in Boston?

A. Probably seven or eight horse-power to a car, making good time.

Q. That would be 800 horse-power to run 100 cars?

A. It might be, but that depends on the grade and track and on the average load carried by cars, and it is a matter for trial; but it might even fall, under slightly altered conditions, to four horse-power to a car, and under some conditions it might rise to ten horse-power. It may take seven and one-half to eight horse-power to a car.

Q. What would a conductor cost, carrying a thousand potential 500 volt extra conductor ten miles?

A. That is a matter that can be figured.

Q. In his paper, he said it would cost $1,000,000.

A. The question, gentlemen, is simply this: It is determined by practical conditions altogether. If you feed in your currents at different points, all the conditions are changed. Of course an electrical engineer naturally consults the best conditions of working.

Q. I only wanted to show the statement that you could put up the overhead system for $2,000 or $3,000 a mile was misleading, and I took that means of showing, as a general thing, you could not do it. You are aware they run over a hundred cars in the city of Boston?

A. Yes, I am aware of that fact.

Q. Do you think you could put up an overhead system to run them for $2000 or $3000 a mile?

A. I understand they do not run all on one line.

Q. I suppose they run a hundred cars on one line?

A. I don't know about that.

Mr. CUMMINGS. In regard to that matter of hauling cars with horses, it is not necessary to put on any witnesses to testify about it. If you put on any horses on these electrical cars at any point, they have to turn the motors all the way? They are geared right into the car. The car weighs 7000 pounds more than the ordinary car. The ordinary horse-car weighs 5000 pounds, and with the electrical motor it weighs 12,000 pounds, and, with your storage batteries, it will weigh 4000 or 5000 more.

Mr. ABBOTT. Did you ever investigate it?

Mr. CUMMINGS. We did, and to the tune of $15,000 or $16,000, too.

Mr. ABBOTT. Did you ever have anything to do with the Julian battery?

Mr. CUMMINGS. We did.

Mr. ABBOTT. What did you do?

Mr. CUMMINGS. We sold them for what we could get, after spending $16,000 in experimenting. I can give you some good advice on the thing you really want to know. Don't put any money into storage batteries. It will be worth your coming up here, if you will only take that advice.

TESTIMONY OF CHARLES J. WOODBURY.

Q. (By Mr. Cummings.) What is your occupation?

A. I am second Vice-President of the Boston Manufacturers Mutual Fire Insurance Company, and engineer for twenty companies known as the Factory Mutual Insurance Company, confining our attention to insurance of manufacturing companies.

Q. How long have you been connected with the insurance companies?

A. Since the 26th of February, 1878.

Q. Whether in the course of your business you have had occasion to look into this matter of electric currents by overhead wires, storage batteries, underground, &c.? If so, you may state to the Committee what investigations you have made on the subject.

A. When the matter of electric lighting was first introduced, in the fall of 1878, it was assumed and expected, perhaps, by the general public, that it was entirely without any hazard of fire. Experience, however, shows that that opinion on the part of the general public was not very thoroughly founded, and from previous experience I had had on that subject, which came right within the duties of my position, I made a great many investigations. You will remember, of course, that there was nothing in books on the general subject of the applications of electricity on a scale sufficient for giving data in regard to its practical use for lighting, and therefore it was necessary to make a great many experiments, some of them being done at mills which were lighted by electricity, and others at factories engaged in manufacturing electric lighting apparatus, the managers of which very cordially co-operated with me in that work, placing at my disposal all the apparatus which they made for the purposes of the work, so that I could ascertain the condition in regard to danger to life and hazard of property. I prepared what was known as the rules of the Boston Fire Underwriters Union, as their consulting electrician in regard to electric works. I had for a year or two the executive charge of wires and inspection in Boston until the matter came down to a better footing, and we found out what was really required of the underwriters in the matter, and since that time I have been merely their consulting electrician, very rarely being called into service in that respect, but in these Factory Mutual Insurance companies they wrote $425,000,000 insurance, and they have a great many buildings lighted by electricity, and the inspection of that electric lighting plant is entirely in my hands, and I am responsible for their work.

Q. Will you state whether you make any different rate where mills are lighted by electricity than where they are lighted by gas?

A. In point of fact we do not make any different rates, but we have always from the first encouraged the use of electricity. As soon as I was able to show to the companies that I represent that the fires from electric lighting were of a preventable nature, although I do not mean to impose any statistics upon the Committee, yet the logical figures are sometimes valuable, I will say that in the fall of 1878 — no, I guess it was 1881, rather, because for the first two or three years there were very few installations — along in the fall of 1881 and winter of 1882, what is known as the lighting season in the mills, we had twenty-three fires from sixty-nine electric light plants, and I dare say we never heard of some other small ones, and after I had charge of the matter, one hundred installations were necessary, laying out new work. From that day to this, although the amount of lights has greatly increased, referring now to nearly five hundred different establishments which are lighted by electric lights of all makes in our market, and managed by such people as they have at the mills, we have not from that day to this had a single fire in that seven years in these increasing number of electric lighting plants, reaching now nearly to five hundred, and I believe we have very logically come to the position of encouraging the electric lights as the safest method of lighting factories.

Q. Have you had any experience in using conduit or underground systems?

A. The question conduit came out in regard to my duties to the Boston Fire Underwriters Union, but as far back as 1884, I believe, when I went to Philadelphia, the first examination of some of the conduits there in use, and also those in electrical exhibitions at other places, and I have been to other cities to examine the conduit system, and as a result of all that I can learn or hear in any way on the subject, I have come to the belief that under the present state of the art of using electricity for arc lighting purposes, that it is not feasible to put the arc lighting conduits under ground, feeling that it would increase the hazards very materially.

Q. Have you had any experience in any way with the Massachusetts General Hospital?

A. Yes, sir, I am the consulting engineer for the Massachusetts General Hospital, and as such have recently installed a large electric lighting plant over the premises. It is virtually an electric lighting station.

Q. In endeavoring to put these systems in, have you ever used the storage battery in any way?

A. No, sir, I have not, although it was my intention to do so in regard to the hospital plant to which you have just referred, but as the result of looking into the matter rather closely, more particularly upon a practical commercial basis than that of the scientific matters involved, I have indefinitely postponed that part of the installation.

Q. For what reason?

A. Because I cannot assure the trustees that the storage battery plant could be put in without liability to accidents, which would deteriorate it and perhaps ruin it, and that its care would require quite expensive help.

Q. Have you ever found any responsible storage battery company which would give you what you consider good guarantee of service?

A. That has been one of the difficulties. It is hardly a matter of public interest, but in a few days I am going to New York for the purpose of conferring with some of the storage battery people. I have had conversation with them, and we might come to terms definitely.

Q. Whether you personally have received any electric current in the course of the experiments and investigations, and if so, what?

A. I received an electric current a number of times. Do you mean to inquire how much potential I have received?

Q. Such description as you can give.

A. When I was in Philadelphia, in 1884, looking up some matters pertaining to the conduit systems, I received a shock from one of the Brush arc lighting circuits there in the city without any injury, above, of course, a sharp pain at the time, and I remember the question of the effect or shock of the electric lighting arc current when I was at the United States Electric Lighting Company's works in Newark; Mr. Edward Weston showed that he could take the shock from one of his dynamos operating, I believe, fifteen lights in a circuit, by touching his hands upon the binding-post, and I found that I could also do it. That would be from three hundred and fifty to perhaps five hundred and twenty volts, but of course there are others that have taken very much higher shocks, but I refer to that as something within my recollection, and where there was no injury or burning even.

Q. In putting any of these systems in the factories and public buildings in which you have been interested, have you ever known of any fatal accidents?

A. I have never had any personal knowledge of any fatal accidents from electric shocks. I have never known, even by hearsay, of any fatal accidents from electric shocks in these large amount of mills I have referred to.

Q. Mr. Woodbury, as a citizen, and as a man who has investigated these subjects thoroughly, I will ask you if you have any opinion in regard to the use of electric power in running cars, as to what systems are practicable and what impracticable?

A. I have rode on electric railroad cars, and have been into some of the stations where the power is generated, and have seen them work practically. I do not fully understand the scope of your question, unless it might be that I believe that whatever method of propulsion of street cars for transit within our cities is used, it must be something that is beyond peradventure, so that it will be successful under almost every circumstance of weather and temperature, because the public must be moved, and the more disagreeable and stormy and inclement the weather, why, the greater is the necessity that such service should be practical and constant.

Q. From your investigation of the conduit for electric lighting purposes, whether you believe, in the present state of the art, the conduit for transporting street cars is practically a success?

A. Certainly it does not appear to be a success in this climate, whatever it may be in a southern climate. What I know on the subject, of course, is very largely from what I have seen and been informed right here in Boston.

Q. Have you ever made the subject a matter of scientific investigation? That is, are you at all an electric expert?

A. I have been called so, yes, sir.

Q. Will you state what, in your judgment, are the reasons that the conduit is not likely to be a success in the winter, in the present state of the art?

A. Because it is not feasible to maintain the electrical separation of the conductors in this conduit from the earth, and one of the bars or conductors in the conduit being what is termed positive, and the other negative electricity, when they are subjected to the water and slush, &c., the electricity, instead of being ready to engage on the collectors and pass through the motor, will pass from one wire to the other and prevent the system from receiving the advantage of the electricity.

Q. In regard to the matter of safety, is there any danger that you know of connected with these underground currents?

A. In connection with our arc lighting where the currents are of five potential, there is considerable hazard, and their use in other cities has been met with a great many difficulties, all owing to the impossibility of maintaining the insulation on the underground system. And this difficulty of maintenance of insulation would naturally occur in the conduits of the street railways, in fact, they would be even more liable, on account of the conduit being open at the top to afford facility for the collectors reaching down from the cars.

Q. In regard to any shock that you may have taken, Mr. Woodbury, have you ever taken a shock as high as 500 volts?

A. Yes, sir.

Q. How high have you taken, as far as you can take that Brush arc light you spoke of?

A. The shock must have been from a current of about two thousand volts. Under some circumstances it was a matter that might have proved fatal.

Cross-Examination.

Q. (By Mr. Abbott.) Whether at any of your mills they run an exposed wire carrying 500 voltage, and carrying a current of 480 amperes, through the yards of your mills, within twenty or thirty feet of the walls, with the telegraph and telephone wires crossing from one mill to the other?

A. There are electric motor cars in some of our mills, and the wires are necessarily arranged in the ordinary way, provided with facilities for taking off the current, but as to the proximity of telephone wires, as a matter of recollection, I cannot answer your question, but would say, certainly all matters of dangerous exposure with our wires either did not exist or were removed by the inspector who examined it for me, or I should have had my attention called to it.

Q. What mills are running these cars?

A. The Tremont, Suffolk and Lowell. They run their cars from the mill to the storehouse.

Q. Do you know the voltage of the wire?

A. Remembering the type, I should say probably 400 or 500 volts.

Q. It is indefinite; you haven't any accurate knowledge of it?

A. I never made any electrical measurements of the system.

Q. Would it influence you in making a risk if you should come into the mill yards and find a wire within twenty or thirty feet of the building, running through the yard uninsulated, carrying a high voltage and high amount of ampere with telephone wires above it — would it influence your opinion as to the insurance of that mill?

A. It would be advisable if there was any chance of metallic contact, in fact very desirable indeed, to put suitable guard wires above it.

Q. And it would be a dangerous affair, wouldn't it, any way?

A. Well, the metallic connection would be bad from one system to the other. It could be obviated, and is done so every day.

Q. Could be, but it is not always, is it?

A. We never had any instance where it is not.

Q. You used insulators there?

A. On the arc lights, not on the motors.

Q. (By the COMMITTEE.) Do I understand that you, as an insurance man, have no objection to placing poles in the street?

A. I don't think it brings any great hazard to the property in the condition it already exists.

Q. (By Mr. GRIFFIN.) Mr. Woodbury, these tramways which run in the mills, do they run in the mill as well as in the arc?

A. Yes, sir.

Q. And this wire is carried right in the mill?

A. Yes, sir.

Q. Is there any difference in the insurance rate?

A. No, sir.

Q. Then you apprehend no danger from that as it is placed now?

A. No, sir.

Q. The lighting wires which run inside the building, you say, are insulated inside the building?

A. Yes, sir.

Q. Suppose those wires, so far as the outside of the building is concerned, running from the source of power generation to the place where they are operated, would that make any difference in the risk of your insuring the building?

A. No, sir, unless the surrounding conditions were such that there might be some metallic connection with this wire outside of the building.

Q. Suppose that was so, would that affect the building through which the wires run?

A. Oh, on the motor wires?

Q. No, I mean outside on the lighting wires; would it affect this building at all?

A. No, sir.

Q. Did you consider there was any pertinence in the comparison between the wire in the streets outside and the wire in the building?

A. I did not.

Q. (By Mr. **Abbott.**) I observe you said the poles in the street would not be any objection. How about the wires? I don't suppose any of us object to the poles, but how about the wires stringing from them?

A. Those wires that are strung from one pole to the other are not a portion of the circuit.

Q. Don't they interfere with the working of the fire engines and getting up on to the ladders, and in other ways?

A. The difficulty has been largely this, — they are obliquely across the street. It would be a very easy matter to cut them.

Q. The first four or five minutes at a fire is the important time, isn't it?

A. The early time is very valuable at a fire.

Q. (By Mr. **Bruce.**) Whether or not you are familiar with the double, simple trolley wires?

A. I believe I have seen something of that kind in connection with the electric motor system of Meredith.

Q. Did you see its operation?

A. Yes, sir.

Q. What was its operation?

A. In comparison with the conduit system, where the wires of different potential are in a conduit, they had two wires of different potential placed overhead.

Q. What is the difference in effect of the two systems so far as regards safety?

A. With the double wire the electricity goes from one wire down through the motor and up to the other one. With the single wire, as many of you are personally familiar with it, the current goes from the upper wire down through the motor to the earth, the difference being a practical way, as far as I recall anything at issue in the matter, which is that of inductive influence on the telephone.

Q. What is the effect of a single wire system upon telephones where they run parallel with them?

A. We hear a purring noise in the telephone.

Q. And with the double system there is not?

A. No, sir.

Q. What would be the difference in the effect of danger from the two systems?

A. There would be as much chance of anybody getting a current through the body, whether it would harm him or not.

Q. That is, with two wires instead of one?

A. Yes, sir.

TESTIMONY OF WILLIAM D. McQUESTION.

Q. (By Mr. CUMMINGS.) What is your occupation?

A. Electrician, and at present in the employ of the West End Railway Company.

Q. In what capacity?

A. As electrical engineer, I believe, so termed.

A. You have charge of the Brookline, and Brighton, and Back Bay system, have you not?

A. Yes, sir.

Q. How long have you been in the electrical business?

A. Since March, 1881.

Q. Will you state whether you have ever personally received the full electric current from the overhead wires?

A. Yes, sir. I received the full current from the overhead wires a great many times.

Q. How recently?

A. I received from the overhead wires in this city on two occasions, once about two months ago, and once three days ago.

Q. By accident?

A. Both times, yes, sir.

Q. Was the line in operation in both cases?

A. Yes, sir.

Q. You seem to be alive. Were you laid up?

A. Not at all.

Q. How much effect did it have?

A. On one occasion it had no effect at all only temporarily; on another it slightly burnt my finger. On the first occasion, I presume gentlemen present in the room saw me take the shock; there was a delegation, I think, from the legislature; I am not positive about that, if not, it was the city council, who were at Allston at the time, and I went to see what the voltage of the current was, and we used an imported instrument there with which I was not familiar, and I got the current from two binding posts, and of course I threw the instrument across the room. It registered 510 volts at that time.

Q. You say you have taken a second shock. How long ago was that?

A. That was Thursday, I think, either Thursday or Friday, I am not positive.

Q. That was the time it burnt your finger?

A. The second time.

Q. Does your finger still show the mark of the burn?

A. Yes, sir, the knuckle is slightly disfigured, a small scar.

Q. How much was the effect the second time?

A. Well, to all intents and purposes the same as the first time.

Q. Except it burned your finger?

A. Yes, sir.

Q. That is, your finger was on the wire?

A. I was pulling a block away and my hand was grounded on the wire, connected with the gas-pipe.

Q. You put this line up, did you not? You oversee the putting up of lines for Mr. Sprague?

A. I had the contract for putting it up.

Q. And after the system was in operation, whether any of your men took the current?

A. Yes, sir, I have had thirteen instances of men who took the current, one last night. We had a lineman who got caught on an iron pole with a hand on the wire, and was hurt, and hollered out. He got a perfect contact with that arm and hand on an iron pole, and the other hand on a large surface of wire.

Q. Was he laid up at all by it?

A. No, sir.

Q. In these cases that you have known, has it compelled a man to discontinue work?

A. No, sir. I have had one man, perhaps more nervous, that was incapacitated for a few minutes, but he went to work again inside of five minutes.

Q. Have you in other cities than in this city, either yourself taken the current or seen it taken, and been knowing to it?

A. Yes, sir.

Q. What other roads have you had occasion to know about besides this one here?

A. Well, Brockton, Mass., I believe a line there, and also some experimental work in St. Louis and San Jose. I have had shocks from all these lines. One line covers all. They are all about the same, varying from 300 to 600 volts. I have had a shock from a 1200-volt municipal machine, built by the Edison Electric Company, which was quite a severe shock, and I felt it for about an hour afterward.

Q. Will you state whether in the course of your experience or observation or even hearsay you have either seen or heard or known of an instance of fatal injury from any overhead electric system for running street cars, that is, where the potential is in one that is used on the street car?

A. I never did to a human being.

Q. Have you had any experience in regard to animals?

A. I would say that animals act very differently under currents from human beings, and that so far as horses are concerned, we have heard something about horses receiving shocks. The frog is the most sensitive animal we know of, the cat is second, and the horse is the third, so far as legitimate contact goes, I mean with the foot, the horse being shod, and the nails running into the hoof come very near the sciatic nerve—I am not familiar with the physiology of the thing—and is the third most sensitive animal that has been experimented with so far as we know. These experiments were made at the laboratory of Mr. Edison. I was present at the time of some experiments, and on one occasion, in Fulton Street, New York, in 1882, we heard that horses were running away up street, and investigation was made. We found that the underground system of the Edison Company, then using 100 volts, had a slight leakage between one conductor and the manhole plate, that is, there was a conductor to the ground and the paving stones through this iron plate, and I saw a horse of the Adams Express Company step on this plate, rear into the air, break one shaft and run down the street. Next came a horse attached to an ash wagon. He didn't look as though he had very much vitality, but when he struck this plate he made quite a jump. Probably there were from one to five thousand people in the street. They had formed two lines, and obliged every horse to pass over this plate, and I went up there immediately, got down and tried to examine with my hand and discover what the leakage was, and I couldn't ascertain any leakage. Briefly, we experimented with that plate until the next morning. Mr. Edison was there, and put one hand on the ground and his tongue on the plate, and couldn't test it and couldn't measure it, and yet these horses with their feet touching it caused them to jump into the air, showing that less than one volt was noticeable to these horses, which shows conclusively that the horse is very sensitive to any current of that kind.

Q. Do you know anything about mules, whether the mule is the same?

A. I understand they are of more uncertain temperment than the horse, but otherwise than that I know nothing about them. In San Jose a mule came in contact with the wire; and in the West End Company two horses before the line was completed thoroughly broke away from the car and became entangled, and for the next week it was almost impossible to get them over this spot. They would rear and plunge away from the side of the street on which the wire was.

Q. Now, this experience you speak of with Mr. Edison in New York, you say that that was from an underground wire?

A. Underground system carrying 100 volts.

Q. Assuming that a 500-volt current is not dangerous to human beings, but is dangerous to horses or mules, or anything else that goes on the streets, which of the two would be the more dangerous, the underground or overhead, that is, be likely to be productive of more danger to animals, the underground system or the overhead system?

A. At the present stage of the art, certainly the underground, because your chance of leakage is a thousand to one or more.

Q. Isn't the chance of contact greater?

A. The chance of absolute contact is not greater, but the chance of leakage by indirect leakage of the wire is very much multiplied. I want to say one thing in regard to the safety of currents: I have been speaking of what we call a constant current. I have heard something here about the danger of 100 volts and 200 volts. It makes a great difference what kind of current you are talking about. The alternating current doesn't come into this discussion at all so far as the experience I have related.

Q. Is there any alternating current or anything analogous in any of the street railway systems?

A. None that I know of, although I believe there has been an attempt in the last sixty days to introduce something of the kind, but the Company who own the apparatus have not succeeded, I believe, in building a road yet.

Q. There is nothing of the kind in this city?

A. No, sir, there is not.

Q. (By Mr. Abbott.) That is, they are not using it now. They can use it, if they want to, on your line?

A. No, sir, they can't use it on our lines. We have a wire, no dynamos, no motors.

Q. The alternating is at the present time a system which is being pressed very much by some very large corporations?

A. By one large corporation.

Q. One of the largest corporations in the country?

A. I understand they are. They have a large capital stock.

Q. If this law passes, why shouldn't they introduce their overhead wires and lines just as much as the other system? They call it more economical, don't they?

A. I believe they do.

Q. (By Mr. GRIFFIN.) Were any of the shocks you received under conditions to which passengers would be exposed on the car?

A. No, sir, none of them.

Q. Would you consider it possible for passengers under the ordinary conditions, as they get on the car and ride on the car and get off, to receive a shock?

A. No, sir, not with the present build of cars. I would like to say that we use lead fusible. At present there are 2000 feet in our trolley wire, which is an upper wire, and the only wire which has any current. That is broken about every 2000 feet, and we take it down to a box on the pole, and there introduce a small strip of lead, and any breaking of this trolley wire, either accidently or otherwise, causes an instant melting of this fusible strip, so we know where to look for it. It will melt at 300 degrees and discontinue the current of the line. The only possible chance for an accident would be for a person to stand with hand uplifted and catch it as it came down.

Q. (By Mr. ABBOTT.) That doesn't cover the possibility of the telephone wire dropping on to your wire when the wire is broken?

A. I know it doesn't cover it. The telephone wire need not drop on to our wire. We have got a system of guard wires wherever there is any crossing over our wires. We guard them with a dead wire, and unless the wire would drop down in a very short bend and then knuckle under so as to come in contact with the wire, it would be impossible to do that. It is a supposition I have not yet been able to see carried out. At Brockton we were required to put them up, and here we have to put them up of our own accord.

Q. Would you object to having what they call a second ground where two wires fall over yours from one wire, your trolley wire, where there are two wires and one falls across it and touches the ground, and another wire falls across it, would you have a second ground? I may not describe it fully.

A. I don't understand exactly what you mean, sir, but with any number of grounds it is impossible to produce over 500 volts. I have taken it, but I wouldn't do it again without I have some good recompense.

Q. You couldn't tell the full quantity? You threw the instrument away from you immediately?

A. Oh, I didn't take a time contact, for five or ten or thirty seconds. If I had staid there a week I certainly should have been dead.

Q. You didn't stay five or ten seconds?

A. No, sir.

Q. Some might?

A. But that wouldn't kill them in that case. It would injure their nervous system for a few minutes. I know of a case where it has been impossible for a man to drop a wire where he had got tangled, and rolled round on the ground for more than five seconds; at least that I know of.

Q. (By ONE OF THE COMMITTEE.) Have you any instance where there was ice on the rail and these electric cars were run?

A. Yes, sir.

Q. Suppose there should be ice on the rail for 100 feet?

A. We couldn't move an inch any more than you could if there was ten feet of ice, or a stone wall.

Q. (By Mr. BRACKEN.) You said there was more leakage from the underground?

A. No, sir; I said the chances were greater under the present state of the art, which I stated.

Q. Are you aware that the wires are underground in London and in Paris?

A. Yes, sir, I am aware of it, but public request—

Q. Do you hear of any accidents in London or Paris?

A. No, sir.

Q. The whole service is underground?

A. Yes, sir, practically. In Milan and Berlin I have heard of accidents. I heard of a man being killed in Berlin through Mr. ———, manager of the Edison Electric Light Station. He wrote me a man had been killed.

Q. You don't mean to say that if a man were walking along the ground, the conduit covered up, that he would get injured?

A. I mean to say the way they are running in New York City they probably will be, because they have only one table in Broadway — a low potential, I believe.

Q. Have you heard of their having underground wires in Philadelphia?

A. Yes, sir.

Q. Have you heard of any accidents there?

A. No, sir. I have not heard of any high potential there.

Q. What is high potential?

A. I don't consider 1000 high.

Q. Would you take it?

A. No, sir. I don't think there is money enough, unless it is a large sum.

Q. When you speak of the Edison 1200 volt current, what ampere was going over the wire at the time of this occurrence in New York?

A. I think it is 160 amperes, thirty amperes on a circuit. It was over 100 amperes, to answer your question. I took it from one brush to the other, so that I got the total output?

Q. I am speaking of the accident in New York, when the horses stepped upon the metallic plate?

A. Oh, there was 100 volt at that time.

Q. (By Mr. Bruce.) Whether or not in Berlin and Paris and London there are very large subways?

A. Yes, sir.

Q. Do you know the diameter?

A. It is five feet in Milan, considerably larger in Paris. From what I have read it is from ten feet up.

Q. Whether or not, with a double system of wires, the effect of ice on the rail would be perceptible?

A. Yes, sir.

Q. To what extent?

A. To the extent of stopping the car. It is not electrical contact we suffer from now, it is traction. It has nothing to do with electricity. It would be true with kerosene, gas, or ammonia. It is not an affect of electrical contact at all. We can get all the contact we want.

Q. With one trolley wire you lose your contact, do you not?

A. Yes, sir.

Q. Would you with two?

A. No, sir.

Q. (By Mr. Cummings.) Whether it would make any difference whether you had had an underground system or an overhead system, or storage battery or an engine, so far as ice is concerned?

A. Oh, no, sir; not if the steam engine was acting of itself; if the steam engine was drawing the cable, either the cable would break or the car would come along.

Q. It is because of slipping on the rail?

A. Yes, sir, it is because of traction, altogether.

Q. The way to do is to get the ice off the rail or —

A. Yes, sir, or get sand on the ice.

Q. Are you aware of the fact that overhead wires are going up in London and that the underground wires are coming out of the subways in Paris?

A. I have heard that was the fact. I am not familiar with what is going on in foreign cities, and I have reason to believe that the newspaper reports about those matters are very much exaggerated. I understand and have heard that city contained certain types of current underground, and because they have been found detrimental to the service of other types they had to come out. I refer to the high potential current on telephones, and also the alternating currents.

Q. (By Mr. Bracken.) Don't you know that they must be not only taken out, but put in a conduit by themselves?

A. No, sir, I don't know that.

TESTIMONY OF CHARLES B. WORCESTER.

Q. (By Mr. Griffin.) Are you familiar with the electric railway at Ansonia, Connecticut?

A. I am, sir.

Q. Have you ever seen any one receive a shock from the overhead wire on that railroad?

A. I have.

Q. Will you describe the circumstances under which that took place?

A. I think it was the 18th of last May. I was building a retaining wall by the side of the electric road. We unfortunately had a derrick fall, striking across the electric wires, and one of the men that was driving teams for me, carting stone, had just driven inside between the derrick and this wire. Another team, a double team, stood back waiting to unload stone, and the derrick fell, striking across the wire, and brought the wire down on top of the first team, and struck across the seat and caught the driver's line between the seat and wire, and the noise started his horse a little, and he tried to get hold of the lines, and instead caught the wire, and that was when he got the shock. He made some noise for a second or so — kind of squealed out, and danced round some and got away from it.

Q. Did it have any after effect upon him?

A. It did not.

Q. Did he go on with his work that day?

A. He did.

Q. Did you see him the following day, and have you seen him frequently since?

A. Yes, sir.

Q. So far as you could see, he suffered no inconvenience from it?

A. None whatever.

Q. (By Mr. ABBOTT.) How many volts was that?

A. I can't tell you.

Q. How many amperes?

A. I can't tell you.

Q. What was the volume of the current?

A. I can't tell you. I am not an expert. I don't know but you would like to know about the horse of the other team.

Q. What about him?

A. I heard that the wire struck one of the horses and knocked him down, but I know the horse got up and worked all right.

TESTIMONY OF CARLO ARZZANI.

Q. (By Mr. GRIFFIN.) Are you the man who received the shock just described by Mr. Worcester?

A. Yes, I am.

Q. Under the circumstances described by him?

A. Yes, sir.

Q. Did you suffer any special inconvenience from it?

A. Not half a minute.

Q. You went on with your work that day?

A. Yes, just as well as ever.

Q. (By Mr. ABBOTT.) Would you like to try it again?

A. Well, not for fun.

TESTIMONY OF BENJAMIN W. PORTER.

Q. (By Mr. GRIFFIN.) What is your business?

A. Superintendent of the electric railroad in Ansonia.

Q. What is your voltage?

A. 500 voltage.

Q. That is the voltage that is nominally used while the cars are in operation?

A. Yes, sir. I suppose the machine is expected to furnish 500 volts, and we use it right along.

Q. You have no volt meter there?

A. No, sir.

Q. (By Mr. Abbott.) How many cars were there in use when this man was hurt, on the 18th of May?

A. We were running two passenger cars and fifty horse-power for our locomotives. I can't tell how many cars were on.

Q. You don't know anything about the accident?

A. No, sir, I don't know anything, only hearsay.

Q. (By Mr. Griffin.) You know as to the machine that is used and the motors that are used on the line?

A. Yes, sir.

TESTIMONY OF JOHN METWIGGIN.

Q. (By Mr. Griffin.) Have you ever received a shock from the electric machine?

A. Yes, sir.

Q. Under what circumstances?

A. Well, cleaning the meter, I happened to lay my hand on the accommodator, which, I suppose, closed the circuit; and standing on the ground with my feet, which were wet at the time, and I received the full current.

Q. Did you suffer any inconvenience from it?

A. No, sir.

Q. Did you go on with your work that same day?

A Yes, sir.

Q. Were the cars in operation that day?

A. Yes, sir.

Q. (By Mr. Abbott.) How do you know you received the full current?

A. I don't know. I suppose I did.

TESTIMONY OF WILLIAM GOWAN.

Q. (By Mr. Griffin.) Have you ever taken a shock from an electric railroad wire?

A I have.

Q. Under what circumstances?

A. At one time last summer, standing on the ground where it was wet (it had been raining all the forenoon), I had occasion to put my hand on the motor, and I got the current.

Q. Where was it?

A. Crescent Beach.

Q. Did you receive the full current?

A. All there was on the line; yes, sir, the cars were in operation.

Q. And you closed the circuit with your body?

A. Yes, sir.

Q. Did you suffer any inconvenience?

A. Not any.

Q. What was the voltage used on the line?

A. Supposed to be running 500.

Q. That is the normal current used on the line?

A. Yes, sir.

Q. Do you know of other employes on the line down there who have received shocks?

A Well, no, I don't.

Q. Don't know of any of your personal knowledge?

A. No, sir.

Q. Was your hand burnt, did you suffer any special inconvenience?

A. One time just a little blister on my two fingers, that is all.

Q. (By the COMMITTEE.) Do you mean to say you have taken more than one shock?

A. Yes, sir.

Q. When was the second one?

A. This winter.

Q. Under what circumstances?

A. I got the connection from the wire on the motor, got a connection with one wire and grabbed hold of the post wire.

Q. Would passengers be ever found in similar circumstances to which you were?

A No, sir, I was under the car.

Q. You wouldn't want to take another one, I suppose?

A. No, I wouldn't wish to, but it didn't hurt me any.

Mr. GRIFFIN. I will say to the Committee that in only one case have I ever found any one who looks upon such a shock as a source of pleasure. We have one statement of Mr. A. F. Mason, the general manager of the Simplex Electrical Company, who says: "In answer to your inquiry, I beg to say, that I consider a 400 volt current is perfectly innocuous. I regard the taking of that current through my body as rather a pleasure than a peril." Nobody wants to subject himself to an unpleasant experience, and we do not claim it is pleasant to receive an electrical shock, but I understand the question before the Committee is, whether it is fatal, or produces very serious effects upon the human body.

Chas. J. Van Depoele, of the Thomson-Houston Company, testified that he had received shocks from 500 volt currents many times without injury, and that he would take such a current in presence of the Committee at any time when desired.

(The hearing was then adjourned.)

Boston, March 1, 1889.

REMARKS OF JOSIAH Q. BENNETT, Esq.

Mr. Chairman and Gentlemen of the Committee, — I am the President of the Cambridge Electric Light Company, in charge of its financial management. I cannot treat of this subject in its scientific aspects, and will simply speak of the commercial results. My views on this matter are in harmony with those of the directors of the Company. We are operating a very complex system in our station, and we are doing almost every kind of electrical work known. We are running arc lights for the city and for stores, incandescent lights of 1000 volts alternating potential; a commercial circuit for motors for small manufactories of 400 volts potential, running throughout the twenty-four hours, and for the overhead system of electric railway, of 500 volts potential. We have had, although organized but a short time, a very great experience in the handling of these various currents. We have changed our system twice, and now we think we know which is the best commercially from the results produced. We operated for the West End Company a system of storage batteries. They experimented on their cars with currents from our station, and our superintendent can give you the results. During those experiments the storage battery was not a success. We then went into the subject of furnishing a current for an overhead system, and that investigation was very thorough on our part, and we carried on a varied correspondence in regard to it. Two propositions were before the City Council to put in an overhead or a conduit system. I think the Board of Aldermen of the city of Cambridge were in favor of the conduit system if it was found to be practicable. The West End Road had then begun to build a conduit in Boston; and, in testifying before the Cambridge city government, I was obliged to differ somewhat from their people as to the results they would obtain. I had caused letters to be written to the Mayors of every city where the conduit system had been placed in this country, and also had corresponded with the companies which had operated it, and, with one exception, the testimony was that the conduit system had been a failure and could not be made a success; theoretically, it was a success, but it had been found to work badly in practice, except in one case in Pennsylvania, where the facilities for operating were better, it had worked pretty successfully, though not as well as the overhead portion of the line.

We have never had a claim made against our Company for any damage from any cause, nor has there been any injury to any employe from electric wires of any serious character, nothing from which any one has not in a short time recovered. I would like to state in this connection that our employes are insured by the Employers' Liability Association, for almost the same rates used in the most favored cases; that is for sixty cents a hundred dollars of pay roll per annum. They get the full indemnity, $5000 apiece for every man. That shows that the Employers' Liability Association, who have made a most careful examination, were satisfied that the danger of death from currents of electric wires was very small indeed.

We are running, and have been for nearly a year, currents of 400 volts potential, for operating motors in Cambridge, and I have not heard of any injury or of the slightest trouble from that current. We are also running 500 volt currents, and we have not received any complaint about those. We are also running 2500 volt currents, and in their operation it has been shown that the tendency is to throw off a person who comes in contact with the wires; he does not retain the wires long enough to receive any serious injury, and the only way in which we have known of a man's being hurt is from his being thrown from a pole and from concussion on falling to the ground, not by the current itself.

If we felt that there was the slightest danger, our Company would not have been willing to run the risk of a 400 volt current, and certainly not the risk of a 2500 volt current. The only trouble has been from the occasional dropping of a telephone wire, which would short-circuit the machine and create some difficulty in the station. We have never had any trouble except from our own apparatus.

Q. (By Mr. Russell.) Do you know whether any claim has been made against these policies issued by the Insurance Company, or against the Cambridge station on that account?

A. None whatever. Our policies have run for some time, and we have been changing our apparatus during that time, and have been more or less in a state of disorder in rearranging our wires, etc., when we were more liable to accident than we are now, and we have not had any accident to an employe which called for any claim upon the Insurance Company.

I would like to have the Committee visit our station, where we can show them the current in operation, and Mr. Van Depoele can take his shock in their presence.

TESTIMONY OF WALTER R. EATON.

Q. (By Mr. Griffin.) State your full name?

A. Walter Eaton.

Q. You are in charge of the Cambridge station?

A. Yes, sir.

Q. What has been your experience with electrical currents?

A. I have handled various currents, mostly incandescent currents, and have taken shocks from them myself.

Q. Of what power?

A. A current of 700 or 800 volts.

Q. Under what circumstances have you taken shocks from a 700 or 800 volt current?

A. From the arc system when running Edison dynamos.

Q. Did it produce any serious effect?

A. I kept on with my work.

Q. How often have you taken those shocks?

A. I have taken quite a number. Many a time when working with a screwdriver I would get my hand across the wires and get a shock.

Q. You don't look upon these shocks as at all dangerous?

A. No, sir.

Q. Have you seen any of the employes receive shocks of 500 or more volts?

A. I cannot say I have seen them take the shocks, but I have seen them immediately after and heard them holler; I have seen them immediately after the shock was over.

Q. Were they incapacitated from work on those occasions?

A. I have never seen any one incapacitated.

Q. Were you in charge of the Cambridge station when the experiments were tried with the storage battery system?

A. I was running a dynamo part of the time, and part of the time I had charge of the station.

Q. Did you see the charging of the storage battery, and can you describe how it worked and what the result was, whether it was a success or not?

A. I did not see the batteries when they were being charged; the batteries were distant some quarter of a mile and sometimes two miles from the station. I can't say how the battery works from observation; but, from the reports the men brought in, I should not call them a success. I should expect to run the cars on the road as they are running now with half the power used with those batteries at that time.

Q. What was the power used?

A. Sometimes they charged two sets of batteries, giving 500 volts, 250 volts each; another time they charged a storage battery with 500 volts. They were charged during the night.

Q. Did the batteries discharge the same amount they were charged with?

A. I see no reason why they shouldn't.

Q. A storage battery charged to give 500 volts, when applied to a street car did give 500 volts?

A. They were capable of giving 500 volts, or more.

Q. How long does it take to charge a battery?

A. Some of our charges ranged from morning until we shut down the circuit the next morning at half past three or four.

Q. How long would they run?

A. If the cars start to run at eight or nine o'clock in the morning and run along until the middle of the afternoon, they would want to be charged that night.

Q. Does it take longer to charge them than to use up the electricity?

A. Yes, sir, a little longer.

Q. How much?

A. I could not tell.

Q. If you want power to run ten hours, will it take ten hours to charge the battery?

A. If you take ten hours to charge the battery, you will get about eight hours run out of it.

Q. (By Mr. Cummings.) Did you ever go into the car house where the batteries were being charged?

A. Yes, sir.

Q. Can you give the Committee some idea of how much room the batteries would take for one car while charging?

A. All the batteries I saw were at the bottom of the cars, took all the room under the seat.

Q. Did you see the batteries as they were being charged outside?

A. No, sir.

Q. Do you remember the size of the room where the work was done?

A. I judge it was 150 feet long, and somewhere as wide.

Q. You never saw the batteries outside the cars?

A. No, sir.

Q. What system of storage battery was used on the cars?

A. The Julien system, I believe.

Q. (By one of the Committee.) How much could a man stand of that charge?

A. The same as from the machine.

Q. Could he stand ten hours of it?

A. No, sir. If he had 500 volts from that battery, I don't think he would want more than ten seconds of it; by the time he took it he would want to drop it. He knows it won't kill him, the same as he knows it won't kill him if he puts his hand on the stove, but he doesn't want much of it.

Q. What effect would it have on a man's head to come in contact with the current?

A. I don't think it would have the same effect as upon his bare hand, because the hair is a non-conductor, and therefore a protection.

Q. It has been stated that a man may receive a shock from one of those storage batteries without injury. How is that?

A. I have received shocks from them, in trying to find out if the current was on, when the batteries were connected; I have received a shock of 250 volts, and it didn't trouble me.

Q. Could a man get a shock from one of those motors after it was filled?

A. I don't see why he shouldn't.

Q. (By Mr. Abbott.) What do you mean by storage batteries?

A. Well, my idea of a storage battery is any battery into which you can pour electricity, by any chemical action, or any action whatever, and which will retain that electricity for some time, and then under certain conditions give it out again.

Q. Did you ever hear of any battery which would retain electricity and give it out again?

A. I think any ordinary battery will give out electricity. My idea is that a storage battery is not different from any ordinary battery. It is a chemical change which causes the current of electricity, and under certain conditions that change takes place and produces the current of electricity.

Q. You think a chemical change goes on and generates electricity?

A. Yes, sir. I think the term "storage battery" is a misnomer.

Q. The technical name is secondary battery?

A. Yes, sir.

Q. You say there is a chemical action causing a change in certain substances, and while this change is taking place the current of electricity is given off?

A. Yes, sir. In the primary battery the change goes on without help; and in the secondary or storage battery the change goes on by forcing the electricity into one hole and out of another.

Q. When the poles are detached, when the connection is not made between the poles, could you detect any electricity in the battery?

A. If I should put a wire into it and the other end into my mouth I should detect electricity.

Q. When the battery is not connected there is no electricity?

A. No, sir.

Q. Then the testimony of Mr. Sprague was correct on that point?

A. Yes, sir.

Q. You say that 250 volts is generated by the storage battery. How is that power got from the storage battery into the car? Is there one cell or a number of cells?

A. A number of cells.

Q. What is the capacity of one of those cells, the voltage?

A. From 2.1 to 2.25 volts.

Q. Is it possible to get out more than that amount of voltage from any single cell?

A. On the first charge you might get a little more.

Q. The amount you can get out of the storage battery means the amount of cells you place in series, doesn't it?

A. That determines the volts.

Q. If the cells are in series you get a little more than two volts from each cell?

A. Yes, sir.

Q. Do you know the number of cells you can carry in a horse car? Practically they never carry more than 120 cells, do they?

A. I don't know the number.

Q. Were you not interested enough to count up the number.

A. I didn't have time, and it was very seldom a man could get into their houses.

Q. Who managed that?

A. The employes of the company.

Q. What company?

A. The company performing the experiments.

Q. What company was that?

A. The Sprague Motor Company.

Q. That is a rival company running an overhead system?

A. They were running an overhead system at that time; at that time the Thomson-Houston system was not in.

Q. It was run by the Sprague Company, not the Julien Company?

A. Yes, sir.

Q. Now if there are 120 cells put into a car, isn't the utmost capacity of that car 240 volts, or thereabouts?

A. Yes, sir, with 120 cells.

Q. That is the most they can run from these cells?

A. Yes, sir.

Q. That is all the number, as far as you can judge, that they ever did use, isn't it?

A. Well, that is all I know of their using on a car on the street; at the same time I have known of more than 120 in series.

Q. They can have more?

A. Yes, sir.

Q. Did they have more than 120?

A. In the cars they were not using more than 120.

Q. They could put cells in series to get a higher number of volts?

A. Yes, sir, but there was no need of it.

Q. Do you know anything of the time required to charge batteries?

A. I have not had experience enough to know about the time; I only know from the time they took when they charged them from the station; the practical time I know something about, I don't know about the theoretical time.

Q. (By a MEMBER OF THE COMMITTEE.) Do you think a person riding in a street car with a storage battery would be affected?

A. I don't think he would be affected in riding, by any current.

Q. You think one is equally as safe as the other?

A. Certainly; that is, any current that it would be practicable to run with; I would say any current they *do* run with.

Q. (By Mr. ABBOTT.) If a storage cell should be set outside, could you detect any electricity there? Take the case of an overhead wire; provided there were no cars running, could you determine whether there was any electricity in that overhead wire?

A. In the same way you could determine from the battery.

Q. If the circuit is not closed there is no current there?

A. No, sir.

Q. When the circuit is closed you have a current of electricity of a certain voltage?

A. Yes, sir, as soon as you make the connection.

Q. When you make the connection, on the overhead wire, you have a current there?

A. Yes, sir.

Q. Would there be a particle of difference, provided the charge was the same, whether you take from a storage battery or an overhead wire?

A. I should as lief take from one as the other.

Q. The current is the same, and you have got to have power enough to run the car?

A. Yes, sir.

Q. You can get a shock from a storage battery as quick as from an overhead wire?

A. Yes, sir.

Q. Supposing the car runs out five miles from the station, and stands on the track, is there any electricity in the storage battery given out?

A. No, sir.

Q. When you run the car by the overhead system five miles out, and it stops, is there any electricity on the line between the car and the station?

A. While it stands on the track?

Q. Ready to operate, so that when the man turns the switch it will work, and you have your five miles of exposed wire covered with a current?

A. Certainly?

Q. When your car stops you don't shut your current off at the car station?

A. The machine shuts it off.

Q. You have got to keep your wire full of electricity all the time?

A. Yes, sir, when the connection is made.

Q. Is there any current flowing in open circuit?

A. No, sir.

Q. The closing of the circuit brings the current over the whole wire instantaneously?

A. Yes, sir.

TESTIMONY OF SAMUEL W. MARVIN.

Q. (By Mr. BENNETT.) You are employed by the Cambridge Electric Light Company?

A. Yes, sir.

Q. Have you recently received a shock from one of their currents?

A. Yes, sir.

Q. When?

A. Day before yesterday I was in the station, and I saw a couple of wires, and I thought I would like to see if there was any current, and I put my thumb on one wire, and touched the other with the other, and it knocked me back a little ways; it didn't hurt me.

Q. What machine was that?

A. The alternating.

Q. The 500-alternating?

A. Yes, sir.

Q. Did you get the full strength of the current?

A. I am not posted in electricity; I got quite a shock; it didn't affect me much.

Q. This was the 500-light alternating machine?

A. Yes, sir.

Q. What is the potential?

A. I was told it took about 1000 volts.

TESTIMONY OF ALVIN S. COOK.

Q. (By Mr. BENNETT.) You are an employe of this company?

A. Yes, sir.

Q. Did you recently have a shock from one of their currents?

A. Yes, sir.

Q. Describe the circumstances of getting the shock.

A. There have been so many — do you mean the last one?

Q. The last one you had.

A. It was from a 1200-light machine; I was adjusting the glass on the machine, the blower, and short-circuited the brushes; it was about 2700 or 3000 volts.

Q. What line does that run?

A. Commercial circuit.

Q. Running arc lights?

A. Yes, sir.

Q. The voltage was about 2700?

A. Yes, sir.

Q. Did you get the full current?

A. I short-circuited the machine, and I suppose I did.

Q. When was that?

A. Night before last.

Q. What effect did it have on you?

A. It threw my arms up.

Q. How long before you got over it?

A. About a second. I did what I tried to do.

Q. That is the stongest machine the company has at work?

A. Yes, sir.

REMARKS OF GEN. E. W. HINCKS.

Mr. Chairman,— I don't appear as an expert, nor as a person who has received a shock, but with reference to the matter of the overhead system, as it has been introduced into Cambridge. For some time the Committee on Roads and Bridges, in the City of Cambridge, of which I was Chairman, have had under investigation some method of transportation which would increase the accommodations of the travelling public. We corresponded with all the companies who have undertaken to run electric cars, we had a large number of witnesses on this matter, we conferred with telephone and telegraph men, and we discussed a variety of methods for the purpose of affording better transportation. Among others we thoroughly discussed the matter of laying a cable, which we concluded was impracticable, for the reason that it would destroy, or render it necessary to rebuild, all the sewerage in the streets where the cable would run, involving an expense of several hundred thousand dollars to the city; and we came to the conclusion that the conduit system, as at present developed, was not sufficiently certain (was liable to great exposure from induction, which could not be observed by reason of the wires being out of sight) to warrant its introduction into our streets. The telephone people argued very strongly against the introduction of the trolley wire for railroad purposes, as interfering with their system more largely, as they proposed to have it, than any other system. We considered the details of the matter of double and single trolley wires, and tried to ascertain the benefits of one and of two wires, and with reference to the double trolley wire we came to the conclusion that while it might lessen the probability of accidents, or the number of accidents, it was almost certain when an accident did occur, that it would be of the severest character, because if a man happened to grasp one wire he would be almost certain to grasp the two.

After a year of investigation, an order was passed by the City Council permitting the overhead system to be put in. It has been in operation now from Harvard Square to Bowdoin Square, with a limited number of cars, for about twenty days, I think, and it more than meets the expectations of our citizens. I think it has entirely disarmed the opposition, which, during the progress of that investigation, was very strong, and created an almost universal demand that the system shall be operated and extended as rapidly as possible, so as to include all our streets.

Now, any restrictive legislation that would prevent the practice of operating cars by the overhead system, it seems to me, would be very unjust to our people, as well as to others. It would deny them better means of transit and larger accommodation than they have before enjoyed since the incorporation of the horse railroads long years ago, which the city has entirely outgrown with the capacity of the roads to serve it. It would work immense deterioration to values of real estate to defeat this enterprise and prevent the happy solution of this whole problem of suburban transportation; because it is evident that this system of electricity by which the cars are to be propelled is capable of moving them at a much higher rate of speed than it is possible to move them by horses. Any person can see the ease with which the speed can be increased in a short distance on a clear track, and it is plainly evident that, with the removal of the horse cars that now interpose between the electric cars, the construction of a better track would come. That is of course necessary to carry the heavier cars, and would enable them to make the distance in from one-third to one-half the time formerly required for transportation of passengers by horse cars. If that is so, it practically solves the queston of suburban transportation.

Now as to the matter of danger. We in Cambridge have been examining that point as a practical question, for the purpose of securing the best method of relief for our people, who have long suffered from unsuitable transportation. Every man in this country knows that during the last four months there has been such an impetus in the demand for electric motors for almost every purpose that many thousands of inexperienced men have of necessity been employed in electrical works; and during that period of four months I have yet to learn that there has been a single fatal accident resulting from the use of electrical currents among those employes, or resulting from the operation of cars themselves. The only case of fatality was that of the poor mule who has been immortalized, and in this instance there was, unfortunately, no *post mortem* examination. He had the misfortune to die in the vicinity of a railroad wire. The papers record the case of a horse who was frightened to death by a locomotive; it may be that this poor mule met his fate in the same way. We have not a single fatal accident recorded from the use of electric motors for the last four months; but every member of this Committee knows the destruction produced by another motor which has been operated, and the power of which has been deeply studied for the last eighty years. Within the last four weeks I have seen accounts in the paper of seven accidents in which from twenty to eighty-three lives were sacrificed by the use of steam motors. If restricted legislation is to be tried with regard to motors, it seems to me it should be brought to bear against the steam motor rather than against the safer motor of electricity.

In Cambridge we are very greatly interested in securing better methods of transportation than we have got, and we feel that it would be an injustice to deprive us of this. I believe the people of Cambridge have no preference for any particular electrical system. The field is broad, and the man who creates the most economical electrical motor, which can be operated with safety and efficiency, will find field enough for its use, without attempting to exclude any other by legislative restriction; its very superiority will exclude others; everything else will yield to it, because the electric motor has come to stay, and the best only will survive; the survival of the fittest is the doctrine just now to put in force.

ADDRESS OF WILLIAM E. RUSSELL, ESQ.

Mr. Chairman and Gentlemen,— I appear at this hearing as counsel for the Cambridge Electric Light Company, that is interested in the investigation now going on; — First, because it operates the motors of the Railroad Company in Cambridge, and next, because an investigation of the safety of overhead wires of that company involves also the broader question of the safety and expediency of all overhead wires carrying electric currents of high potential; and, as whatever action this Committee may take will necessarily affect my client, it desires to be heard with evidence on this subject. I shall confine my remarks to a few words on the necessity and safety of these wires, and what would be the result of restrictive legislation or of failure to grant such legislation as is required for the further development of the successful experiment now being tried in Cambridge.

Cambridge has for many years suffered from inadequate means of transit, being injured from this cause more than any other suburban place. It has been inadequate because the transit is slow and insufficient under any possible arrangement of horse cars. The long time necessary to go from Cambridge to Boston in the crowded horse cars, has made all of our seventy thousand people anxious for some other means of transit. So, in spite of all their objectionable features, she has welcomed the elevated roads as a possible solution of the difficulty. Already she has granted a location to them in her streets, notwithstanding the great inconvenience of such a structure in the streets, and the certain injury it will be to private property. But luckily, as I think, before that location has been built on, there has come a better, surer and safer remedy, and one far less objectionable or injurious to private property. In the consolidation of the horse-car companies, it was hoped and expected that the West End Railroad, with its great resources, energy, and evident wish to serve the public faithfully, would find some method of quicker transit. This task it at once undertook, and has now accomplished in its overhead electric system. Already the people are getting better accommodations, more cars, that are better lit, and better run, with a certainty of much quicker transit when the line is fully equipped, and not blocked by cars run by horses. I have never seen a change of anything like its magnitude which has received such general and instant approval. The universal wish now is that it shall be extended over all its lines in Cambridge, because of its own advantages, and not less because it does away with the necessity for an elevated road, which would be far more objectionable to the public in the streets and to all abutters along the streets. Much has been said about the relative value of overhead and underground wires. Mr. Bennett, President of the Cambridge Company, who will be a witness before you, has made a personal investigation of the success of the underground system, by correspondence with every city in which it is in use. With one exception, the report is unfavorable to that system. I know that when the matter was under consideration before the aldermen of Cambridge, the West End Company expressed a strong wish that the conduit which was then being built in Boston, should prove a success, and if it was that it should be finally adopted in Cambridge. At that hearing, Mr. Bennett stated the result of his investigation, and predicted that the conduit could not be successful. The result of his prediction has been verified. After a most patient and thorough trial, and great expense, it is stating it mildly to say that the conduit system is unsatisfactory. To compel its adoption by legislation hostile to overhead wires, means for us in Cambridge an abandonment of the electric system, and must mean a return to horse-cars, with insufficient accommodations and slow transit. This Committee will not take such action which would greatly inconvenience the public unless public safety certainly requires it. A single word, then, Mr. Chairman, as to the danger from overhead wires. I do not propose to enter the field that has been so fully covered by expert evidence. They have clearly shown you how little harm can come from such wires. I shall speak of it not technically but in a simpler way, believing there is a very erroneous popular opinion as to the danger from electric wires.

The Cambridge Company has been established now some years. It has miles of wires in many streets, all of them overhead. It runs arc and incandescent lights, motors for industries and motors for street cars. The currents over those wires vary from 500 volts (used by the cars) to 3000 volts. Some are constant, and some are alternating. During its whole existence, not one single claim for damage to any person or to any property has been made against the company. What stronger evidence could be produced of the safety of these wires? People may speculate as to possible dangers, but the facts show that such dangers do not exist. One other fact. The company insures its employes against accidents. These employes are working all the time over and above its dynamos, and along its wires, and they are constantly liable to all the dangers that exist from strong electrical currents. The rates for such insurance are exceedingly low, as low, I suppose, as against accidents of any other nature, and no claims have been made upon these policies. Of course the men get electric shocks, but they are not fatal or serious. Within a few days there have been two such cases, both of which will be in evidence before your Committee, where men have received the full force of a 1000-volt alternating current, and of a 2700-volt constant current.

Under these circumstances, there seems to be no occasion for the legislature to pass restrictive legislation. To compel wires to go underground with the conduit system, as yet undeveloped and unsatisfactory, means not only to prevent further development and extension of the use of electricity, but a serious, if not fatal blow, to its present use. Prof. Thomson has said that it would compel the abandonment of the electric road at Cambridge. It must be fatal to the electric light. Such a course, therefore, would be a great public injury. Mr. Chairman, the local authorities in cities and in towns have full power to remedy any inconvenience of overhead wires to the public, or any trouble that arises from conflicting wires, without the passage of stringent restrictive legislation. They are the ones most interested, most competent to decide what is needed, and are ever watchful of the public interest. No one objects to such proper regulations as they can give, either as to the locations or use of such wires. The company I represent has already petitioned the City of Cambridge for the appointment of an inspector for the performance of such duties. Regulation by local authorities exists now, and is proper and sufficient, and restrictive prohibitory legislation seems to me unnecessary, and it certainly will be fatal to electric interests, and so a public misfortune.

ADDRESS OF E. W. BURDETT, ESQ.

Mr. Chairman and Gentlemen of the Committee:

I represent certain electric lighting interests, and especially the Boston Electric Light Company. I have not found it necessary to take much part in this hearing up to this time, and shall not now detain the Committee except with a few words, which will confirm what might be termed the negative testimony already given in the same direction.

The Boston Electric Light Company, which I represent, is an amalgamation of four other companies. It performs all the electric lighting work in Boston, with the exception of Charlestown, where the work is done by the Charlestown Gas Light Company, and that portion of the incandescent work which is done by the Edison Illuminating Company of Boston. It is a combination of the former Brush, Merchants', Weston Illuminating and Citizens' Electric Light Companies. Its plant is the largest in New England, and one of the largest in the country, if not in the world. I will not venture to state the number of hundreds of miles of wire which it maintains in the air throughout the limits of the city, but it is very great, and it has not a foot of underground wire. It operates quite a number of different systems and electrical machines, among them being the Brush, the Thomson-Houston, the American, the Weston, and one or two others. Its experience, therefore, is very extensive with the use of overhead wires, and most of the wires used are of a high potential.

I wish simply to say this, — and if the Committee desires any testimony upon this point I can produce it from the officers and employes of that company to show the truthfulness of my statement, — that during the history of this company there never has been a single accident of any serious character whatever happening from contact with their machines or with their wires.

The company maintains a large station on Ferdinand Street, near the Providence depot, the former Brush station, so called; it also maintains a large station near the tracks of the Boston & Albany and Providence Railroads, formerly the station of the Weston Company, and which now bears the old sign of the Weston Company. It also maintains a large station in Congress Street, Boston, and a small station in Condor Street, East Boston. It is building the finest electric lighting station, I venture to say, in the country, on Atlantic Avenue, in the neighborhood of the New York & New England Railroad. It therefore has an experience in the use of overhead wires more extensive than any that has been testified to here, and I am prepared to prove, if necessary, and I assert, subject to contradiction, that in the history of the company there has never been an accident, either from contact with the machines, arc or incandescent, or with the wires, of any serious character. There has never been a complaint of a man killed; there has never been a man, woman or child injured enough to make a complaint. More than that, I can say that the Legislature of last year, as all of you probably know, passed an Act which went into effect on the 30th of June, 1888, providing that Electric Light Companies and Gas Light Companies should report to the Gas Commissioners within twenty-four hours of the happening of any accident, the nature of that accident, when and where it occurred, and all the circumstances connected with it. I notified our company immediately upon the passage of that Act, and it has never had occasion to report any such case. On Saturday last I inquired at the office of the Gas Commissioners whether any of the Electric Lighting Companies in Massachusetts had ever made a report of an accident in pursuance of the provisions of that law, and was informed that not single case has been called to the attention of the Commission, whereas there had been four cases of accidents reported under that law to the Commission arising from the use of gas.

Now, in connection with the prosecution of the arc and incandescent business to the extent which I have described, the Boston Electric Light Company also operates a power plant. I suppose that is more strictly analogous to the overhead wire plants which have been chiefly talked about in this hearing than the others, and I think the facts which I have stated are of importance in this view; that while the electric power of the current used by the railroad is one of only 500 voltage, our wires carry, as has been testified here, from 1200 to 3000 volts on the arc machines. Prof. Thompson knows much better than I how far these currents vary in their voltage. I think his machines run from 1200 to 3000, and the others about the same.

Prof. **Thomson.** The highest is 3000, and it goes down to anything that is required.

Mr. **Burdett.** 3000 is the highest, and the currents are always in the neighborhood of 2000 or 3000. Now, what I was about to say was, that in connection with the electric lighting plants we have a power plant, which we hold under a lease, and that power plant is running its wires into factories and workshops, and so far there has been no complaint — certainly not since the Boston Electric Light Company acquired it — no complaint of any accident arising from the use of those wires.

The Committee on Cities is to begin on Wednesday next a hearing upon two orders, one the petition of certain citizens of Boston for the creation of Boards of Special Commissioners for the purpose of converting the overhead system of wires into an underground system, and another an order of inquiry into what methods may be employed for the further protection of life and property from overhead wires. Before that Committee, at that time, that being the precise question in issue, we shall take pains to introduce such testimony as we may deem important on that subject, and I call attention to this matter to-day simply in order that, if they see fit, members of this Committee may follow up the subject there. The orders before this Committee seem to be limited to wires for the propulsion of street cars. For that reason I have thought that it might be considered presumptuous for us to offer any direct evidence in reference to electric light lights. This we shall do at the other hearing which I have referred to. But the fact that we can run hundreds of miles of wires with a voltage of two or or three thousand, through a densely populated city like Boston, without accident, would seem to be a pretty conclusive reason why this Street Railway Company can run wires carrying a voltage of 500 only without any fear of damage.

Mr. RUSSELL. It is true in Cambridge, and I believe it is also true in Boston,— I think Mr. Burdett will confirm it,— that there has been no claim made against our company for damage to person, nor any claim made against the company for damage to property, by reason of any accident.

Mr. BURDETT. That is true of Boston.

ADDRESS OF HON. HENRY BALDWIN

I do not know what I can say. I have been highly interested and perhaps instructed, with reference to the matter of liability to accident, by what I have heard here. I have no interest in this matter of electricity except that of a common citizen. I am not interested in the West End Railway at all; I am simply interested as a citizen. The electric system of the West End road runs by my home on Harvard Avenue, in Allston. I think it begun late in December or early in January; it has been in progress some two months or a little more. I will simply say, in a word, that I like it very much. I should deem it a great misfortune if the overhead system and the electric cars did did not run by my home and did not run on Harvard Avenue. I think it has given a great impetus to the prosperity of the community in which I live. I am not particularly in favor of high prices for real estate; I do not speak of that as a great argument in favor of this system; but there are large numbers of people now who are seeking places where they may buy land on which to build houses in which to live, and invariably they seek those sites on the line of the electric railway. Now, this system, had I not seen it at Richmond, I should have felt, perhaps, would be unsightly, but, as you have all seen,— I cannot instruct this Committee at all in regard to that,— it is not unsightly, and I do not know but it is rather ornamental than otherwise. Whether it is ornamental or not, it compares very favorably with the telephone and telegraph posts. I am more than pleased with what I see of the results of this system with us. Of course in coming from my home to the city I strike two systems; that is, there is the overhead system, and then there is the conduit system. For myself I should very much prefer, as the case stands now, the overhead system to the conduit system. I do not know what particular question is before this Committee, but I am simply here to say, as a citizen, residing on the line of this overhead system, that I am more than pleased with it, and I should be very sorry to see it removed.

Hon. SETH J. THOMAS next addressed the Committee, expressing his preference for overhead system as against the underground system, on the score of its greater cheapness. He had never known of any danger from it, and did not regard it as unsightly. It was true that horses would turn away from it as they would from other unfamiliar objects, but he thought that any horse of decent temper could be taught in three weeks to go by these cars without any trouble.

ADDRESS OF HENRY M. WHITNEY, ESQ.

Mr. Chairman and Gentlemen,— I have here a letter from Mr. Franklin L. Pope, who is the electrician of the Westinghouse Company, standing in very much the same relation to the Westinghouse Company that Mr. Thomson does to the Thomson-Houston Company. This paper, which I shall leave with the Committee, is merely cumulative evidence upon this question, which is one that is of great interest, I think, to almost every citizen of this State, and, indeed, of the whole country. Mr. Pope, who was here at the first hearing, and whom I regret very much is not here to-day, has been in the habit of going abroad in behalf of the Westinghouse Company, for the purpose of keeping the run of electrical development and progress in foreign countries. I met him not long since, before this hearing was announced, and he told me that on a recent visit abroad he went to Switzerland for the purpose of observing there the progress that was being made in the use of electricity in industrial enterprises. He says that in Switzerland there is a greater degree of development of electricity for industrial purposes than anywhere else in the world. He tells me that every single stream is now being prospected and examined, and in many cases used for the development or for the transmission of power for industrial purposes in a manner that has given to the Swiss people great hopes for the future of that country, and is leading to a degree of industrial development which is certainly astonishing to a man who has not been familiar with it from the beginning. He told me that he visited one mill where they were running a 450 horse-power dynamo. That dynamo was located far up upon the mountain side, and it fed its power to a mill four or five miles away in a village where it was possible to use the power to advantage.

Now, Mr. Chairman and gentlemen, the growth of this electrical service is of very great interest to your constituents and to everybody in this whole State of Massachusetts. If it be true that we can utilize the streams that are now running to waste for the purposes of power, if indeed we have in our midst something that can take the place of the cheaper gas and the cheaper coal of more favored States (and I believe absolutely it is true), that is something that is of very great interest and importance to the people of this State; and if the Julian Company have done nothing else, they have enabled testimony to be brought before this Committee which, if spread before the citizens of the State, makes clear the whole subject as to the dangers and advantages of this electric system. I claim that what the people of this city and of this State want is information. They desire to know the true nature and capacity of this power, and if the testimony which has been produced here, entirely unimpeachable as it is, can be spread abroad throughout this community, it will certainly be of great value to those who desire to judge of this system. Here is a mass of testimony upon this subject which astonished me; I had no idea that the current was so harmless. Indeed, from all the evidence that has been produced before the Committee, it might almost be said there is no dangerous current. When you talk about "a dangerous current," what do you mean? You do not mean simply the danger that comes from a man putting his hand into the fire and burning it. "A dangerous current" means danger to life and nothing else. If people understand that the danger of the current is simply the danger of a temporary inconvenience, that is quite a different thing from what people generally understand to be the effect of an electric current, and very different indeed from what the Julian Storage Company would desire to have this Committee understand.

Now, Mr. Chairman and gentlemen, so far as relates to the carrying of this current of electricity by overhead wires, the West End Railway is largely interested in that subject. It has behind it a large community who are desirous of some improved means of transportation. The officers of this Company have been in search of that means for the last two years. We were the first to try the Julian storage battery. I went to New York to witness an exhibition of it, and I dare say there are other gentlemen here who had the same experience. Two or three years ago there was a Julian storage battery car brought into New York; it was heralded with a very great flourish of trumpets, and the street railway men far and near were invited to come and ride on this car. I was one of those who went, and this car was brought out from the stable on Sixth Avenue, I think, at that time, and we did make a little trip up and down the street. It could not climb a grade at the rate of over two or three miles an hour. It could not go as fast as a horse car at that time. The reason they said was, that the wheels were not right. There were a great variety of excuses made why the car did not do what it ought to have done; but that car had at that time been in New York several months; there was no reason under heaven why all those things could not have been eliminated and the car shown to the best advantage. But, notwithstanding that, so strong was our desire to try everything that might by any possibility be made available for our purposes, that under the advice of Mr. Pope, and after consultation with Mr. Sprague, we decided to have a car built. We did not take an electrical expert such as has been produced here by the Julian Storage Company, who had never seen an accident and never knew of one except by what he had read in the papers. If we had tried our experiments under such auspices, we might well have doubted the result. But instead of that, we went to Mr. Frank J. Sprague, a man who had done more than any other man in the country to popularize the electric system, and who is the head of the Sprague Electric Railroad Company; we went to Mr. Franklin L. Pope, the trusted expert of the Westinghouse Company, and to Mr. Prescott, at present in the employ of the New York Accumulator Company, all first class men, and engaged them in this service. We spared neither time nor money to make that storage battery a success. We employed the best talent that we could find; we supplied unlimited money with which to make these experiments, and the result was that we ran those cars a few times, until the people of Cambridge who knew anything about it voted them a nuisance. I appeal to Gen. Hincks if that was not the fact. We then abandoned it. Whatever the Julian Company may say in behalf of its system, that you can, by bringing together the best electrical experts, make a success of it, certainly we, who must give these cars in charge of our drivers, are not in a condition to use it. And I want to call the attention of this Committee to this fact: that the Julian Company comes here and claims that here is a system that is suited to our street transportation, but it does not present a single person, nor even a letter or line from any person who is using it, to show how they regard it.

Mr. Abbott. I think you are making a mistake, unintentionally. We put in a report from the Fourth Avenue Company.

Mr. Whitney. Did you put in anything to show how the people in New York who use that road regard it?

Mr. Abbott. I understood that Mr. Bracken did.

Mr. Whitney. If he did I did not hear it. I say that there has been nothing shown before this Committee to satisfy them that the storage battery is in any way a possible solution of this transportation question. A year and a half ago I was in Philadelphia, — I dare say Mr. Shaw of this Committee has also been there, — and they had fitted up in their yard a storage car, and we were invited to get into that car, and it ran around the yard a few times. That was the beginning and end of the work of that car. William Wharton & Co., of Philadelphia, had two cars fitted up that they ran around this yard and a little way out into the street, and that was the beginning and end of it all.

Last summer, in pursuance of this desire to do something for the improvement of transportation, we visited the cities of Richmond and Allegheny, to examine the electric systems in operation in those cities. We found in the city of Allegheny a conduit system, the only conduit system in existence, the result of years of experiment by the Bentley-Knight Co., and believing that it was necessary, in order to popularize this electric system throughout the city, that a conduit should be put in, although recognizing the fact that it was very much more complicated than the overhead system, we decided, against the advice of Prof. Thomson and others, who predicted its failure at the start, that it was necessary for us to make a trial of this conduit system. We did make a trial of this conduit system in the very best possible way. There was no expense spared in putting in this conduit. It was placed in charge of the Bentley-Knight Co., one of whom was the inventor himself, who was certainly more interested than anybody else in its success. Those men have had charge of the work of construction from the start. Not only that, but all the mechanical skill possessed by the West End Railway has been placed at the service of these men for the purpose of developing and perfecting this system. Not only that, from the beginning to the end of its construction, or from the time of its opening until to-day, there has not been an hour or a moment when every single resource of this corporation has not been brought to bear to make that conduit a success; and any man who says or intimates that there has been any desire that this conduit should not be made to work, that the company have not acted in good faith from beginning to end, and are not doing so to-day, says what is absolutely and unqualifiedly false.

These things, Mr. Chairman and gentlemen, have not been done in a corner; they have been done openly, in the eyes of this whole community, and this community knows that I speak the truth when I say that, from the beginning to the end of this experience, there has been no pains spared to make it a success. And let me say further, in justice and as a matter of honesty and truth to the Bentley-Knight Company, that I believe that this conduit system which we have here on Boylston Street possesses more advantages — indeed, I know it possesses more advantages — than any conduit system of which I have any knowledge. These gentlemen have been at it for years. They have perfected the system and its mechanical appliances to a greater degree than has been done by any other company; and, if any conduit system is ever made to operate with success, I believe that it will be their system. It is unnecessary for me to state why it fails. Indeed, I do not know. All I can say is, that — in spite of all the efforts that we have made, in spite of all the efforts made by the Bentley-Knight Company — this conduit system is not to-day in such a condition of perfection as to warrant our extending it a single foot. For a few days, perhaps, the cars will run regularly, and then there will be, for what reason we cannot tell, a delay of from five minutes to two hours. It would not do for us to have any such system; indeed, the citizens would not permit any system which should retard the progress of the cars through the streets for even a minute. The most simple and reliable system is the one that is demanded by the community to-day.

Now, Mr. Chairman and gentlemen, we come to what we consider and what I believe, by the universal consent of the citizens of this great community, is considered as the only practicable system to-day, and that is the overhead system. It has been shown here, by evidence that cannot be questioned, that there is absolutely no danger to life from the current carried over these wires. So far as the question of the management of fires is concerned, it is in evidence that you can cut away all these wires in the vicinity of a fire and immediately the fire is over you can join the two sections again and your cars can run as they did before. I speak, Mr. Chairman and gentlemen, with a very great degree of confidence in the result of this hearing, because I know that behind this petition is the great desire of this community. I know that upon this subject the community are hand in hand with the Railway Company, and that they desire that there shall be no legislation, not only which will prevent the introduction of this system, but, if any legislation is necessary to promote and encourage its introduction, the community desire to have such legislation. We know this from the testimony that comes to us every single day. We could produce a thousand letters and ten thousand people if the Committee wanted any evidence of it.

As to the unsightliness of the structure, as General Hincks, Judge Baldwin and Mr. Thomas have said, the sentiment and feeling of this community in regard to overhead wires since this system was put in has entirely changed, and, so far from regarding it as objectionable, there are thousands of people who would infinitely prefer it to-day to the underground system. I understand that the right of the West End Railway to put in an overhead system on poles has been called in question. If there is any doubt about that, I should fail in my duty to my corporation and to the individuals whom this corporation desires to serve by this system, if I failed to ask this Committee to correct anything in the law which does not give us the right to do it. If the West End Railway Company has not the right under its legislation of two years ago to put in the system, then we respectfully ask that we may be included in any legislation which confers that right upon others. I believe that the community are anxious to have this system introduced. I know a large expense will be involved in putting it in, but I believe that what the people desire should be put in, and they desire that the legislation upon this subject shall be liberal, so that the company can proceed as rapidly as possible in accomplishing it.

Mr. ABBOTT. Mr. Bracken was simply put on to give his testimony in the matter, and he certainly appeared very fairly before the Committee; but, as Mr. Whitney has brought the matter up, I would like to ask him how long it is since he has seen the Julian system at work?

A. I think our car ran last summer or last fall.

Q. Not your own experiments, but the experiments of the Julian Company, where the experiments were conducted by the Julian people, not by your own people?

A. We bought the storage batteries of the Julian people and turned them over to the best electricians we could get here.

New York, February 26th, 1888.

To the Chairman of the Committee on Street Railways:

Dear Sir, — As a property owner and tax payer, although not a citizen, of the State of Massachusetts, I desire to make some observation in reference to the bill now before the Legislature authorizing the operation of street railways by electricity.

The dangers to persons and property arising from the multiplication of the electric wires in streets, thoroughfares and public places, although to a certain extent justified by facts, have been unreasonably exaggerated. It is clear to every observant person that the use of electricity for lighting and motive power is rapidly becoming one of the most potent factors of modern civilization, and cannot but enormously increase the comforts and conveniences of life, but the facilities of manufacture and transportation. This development of electrical enterprises, so desirable in many respects, may be seriously hampered by unreasonable prejudice, and illiberal and unnecessary restrictions. It is my conviction that the policy of the State should lie, not in the direction of prohibition or arbitrary restrictions upon the construction and use of electric conductors, but in that of rigid, and at the same time intelligent, supervision and regulation. With such supervision and regulation the dangers both to person and property may be reduced to a minimum. Under the management and oversight of well instructed and careful persons, electricity is one of the least dangerous forms of force; but, in the hands of ignorant and careless persons, it may easily become one of the most dangerous.

The foregoing remarks must be understood as applying to electric service generally. With reference to the particular question before your Committee, which, as I understand it, relates solely to the possible dangers to life and property which may arise from the presence of suspended electric conductors for the purpose of operating electric street railways, I would say that there are now in operation in the United States some fifty of these roads of the length of five miles or less, nearly all the mileage of which is situated in the most prominent thoroughfares of cities and large towns. As editor of a journal devoted to the interests of practical electricity, and having had an extended experience in the actual practice of electric engineering, I have exceptional opportunities for information respecting this class of enterprises, and I affirm that not a single instance has ever come to my knowledge of any person having been killed or seriously injured, either in the United States or in any other country, by the electric current from a street railway conductor; and I do not think that a single such instance can be pointed out by the opponents of such enterprises. The electrical pressure which has been settled upon, as it were, by common consent, for electric railway work, is in the neighborhood of 500 volts, a pressure which, although high enough to secure economical and efficient operation, is undoubtedly well within the limit of danger to human life. It is but little more than the pressure of 400 volts which has been used for years on many of the main lines of the Western Union Telegraph Company, and, so far as I am aware, without injurious results. A current of 500 volts, though capable of producing great pain and nervous shock if passed through a person would not permanently injure or incapacitate such person. Instances have been recorded (upon how good authority I know not) in which horses have been killed by eletric railway currents. This is quite possible, because the nervous system of the horse is well-known to be exceedingly sensitive. Many instances have been reported of horses falling dead from fright caused by the sudden apparition of some unaccustomed object, such as a locomotive, and the same result might easily follow from the intense pain resulting from the contact of an electric wire charged with 500 volts. I do not, however, believe that a current of this pressure can in any proper sense be said to be dangerous to human life.

As to the danger of fire arising from the accidental contact of other wires, conveying the current into the interior of buildings, such danger unquestionably exists, but it is quite certain that it may be minimized, and, in my opinion, avoided altogether, by the use of proper precautions. It should not be possible for a telegraph or telephone wire to fall upon an electric railway conductor, except in rare instances; but, even should such accident occur, its effects may be avoided by the use of a simple protecting device which is largely used in the city of Philadelphia* in the telephone service and by the Western Union Telegraph Company in all of its larger stations. This device is so constructed that, upon the appearance of an abnormal current upon the wire, it is automatically disconnected from the instrument and connected directly to the earth, at a point outside the building. This device has been found by the Western Union Telegraph Company to be almost an absolute protection. That this is the fact is sufficiently proven by the circumstance that so few fires have occurred in telegraph offices, although the mileage of wire connected with them is probably a hundred times as great as that connected with the telephone or any other service.

So far as it is proper for me to suggest any action, I should advise that it be in the direction of careful supervision by proper authority, having regard to the circumstances of the case. A pressure which might be safe under one set of conditions might be highly dangerous under another. Just as it might be perfectly safe to run a locomotive through the crowded streets of a city at the rate of three miles an hour, and equally safe to run it through an uninhabited country at the rate of sixty miles an hour. It would seem as if legislation in the direction of arbitrary prohibition or restriction would be undesirable, but State and Municipal regulation, carefully guarding the life and property of the citizen, and yet not unnecessarily obstructing the free circulation of electricity for industrial purposes, I regard as eminently practical and desirable.

Very respectfully,

FRANKLIN LEONARD POPE.

AFFIDAVIT OF WILLIAM H. WILLIAMS.

William H. Williams, a resident of the City of Washington, District of Columbia, being duly sworn, deposes and says: That he is an employe of the Thomson-Houston Electric Company, his principle duties being in overhead construction. That he has been on duty with the Eckington and Soldiers' Home Railway Company since the beginning of its construction. The said Williams further deposes and says that on or about the 12th day of December, 1888, while working upon the switchboard at the station of said railway, replacing temporary with permanent wires, he was standing upon a ladder, one step of which broke, and to save himself from falling, he caught hold of the positive and negative lead wires, which were uninsulated. He received a severe shock, but one which did not incapacitate him from the exercise of his duties. The dynamo was running at its normal capacity, being about 495 volts. The current was short-circuited, and to the best of his knowledge and belief he received the full force of the current through his body.

WILLIAM H. WILLIAMS.

WASHINGTON CITY, } SS.
DISTRICT OF COLUMBIA, }

Sworn to and subscribed before me this 23d day of February, 1889.

S. HERBERT GIESY,
Notary Public.

AFFIDAVIT OF JOHN F. DORSEY.

John F. Dorsey, a resident of the City of Washington, District of Columbia, being duly sworn, deposes and says: That he is an employe of the Eckington and Soldiers' Home Electric Railway Company, of said City and District, and performs the duties of lineman on said electric railway. The said Dorsey further deposes and says that on or about the 25th day of October, 1888, he was putting up a stay-guy wire, and that guy-wire that was up became crossed with another guy-wire that led from the main line or the overhead conductor. Thinking the guys were well insulated from the conductor, he went up the pole with the guy-wire in his left hand, the other end of said wire lying across the track just in front of the car house. After reaching the top of the pole, to steady himself he reached out and caught hold of another guy-wire which happened to be in circuit with the overhead line. At that moment he received a severe shock which affected him for perhaps twenty minutes or one-half of an hour. He immediately dropped the wire which he carried up the pole, and then came down the said pole, and commenced to investigate to find the cause of the leakage. He discovered that about 300 feet distant the guy which he had grasped with his right hand was crossed with a short guy-wire connected with the main or overhead line. The current passed from the generator along the main or overhead line to the short guy-wire, thence to the cross with the other guy-wire, and thence through his right arm to his left arm, and thence through the wire in his left hand to the track, and thence back to the generator, causing what was called a short-circuit. The said Dorsey further deposed and says that the shock did not interfere with the continuous performance of his duties, and he further deposes and says that an employe came to him from the engine house and told him they had just had a short-circuit, and asked him (Dorsey) if he had caused it, which he (Dorsey) explained.

JOHN W. DORSEY.

CITY OF WASHINGTON, }
DISTRICT OF COLUMBIA, } SS.

Sworn to and subscribed before me this 23d day of February, 1889.

S. HERBERT GIESY,
Notary Public.

[Copy.]

THE STATE OF OHIO, }
MONTGOMERY COUNTY, } S.S.

William W. Shoemaker, being by me duly sworn, says that he is a resident of the City of Dayton, Ohio, and Superintendent of the

Police; that he was present at the test made by Elmer Morris, as in his affidavit stated, and fully corroborates all that said Morris says in regard to said test; that he allowed Morris to try same test on him without any apparent effect.

W. W. SHOEMAKER.

Subscribed in my presence, and sworn to before me, by the said William Shoemaker, this 25th day of August, A. D. 1888.

BARRY MURPHY,
[SEAL.] *Notary Public in and for Montgomery County, Ohio.*

[Copy.]

THE STATE OF OHIO, }
MONTGOMERY COUNTY, } SS.

Before me Barry S. Murphy, a Notary Public in and for said County, personally came Elmer Morris, who, being by me duly sworn, says that on or about July 20th, 1888, he, as the managing electrician of the White Line Street Railroad Company's Plant in the City of Dayton, Ohio, placed himself in the circuit of an eighty h. p. generator, giving an E. M. of 500 volts, by placing one hand on the positive wire and the other hand on the negative wire, remaining in the circuit about four seconds. Affiant did this to convince citizens and officials of the said White Line Street Railway Company, who were present, that there is no positive danger from 500 volts. Affiant has tried the experiment numerous times without any apparent effect or damage to himself.

ELMER P. MORRIS.

Subscribed in my presence, and sworn to before me by the said Elmer Morris, this 25th day of August, A.D. 1888.

BARRY MURPHY,
Notary Public in and for Montgomery County, Ohio.

[Copy.]

THE STATE OF OHIO, }
MONTGOMERY COUNTY, } SS.

Before me, Barry S. Murphy, a Notary Public in and for said County, personally came William Kirby, Fred J. Funk and Charles Ewin, all residents of the City of Dayton, Ohio, who, being by me duly sworn, say that they were present by invitation at the test referred tc by Mr. Elmer Morris, and fully substantiate all that he and Chief Shoemaker say in regard to same.

WILLIAM KIRBY.
FRED J. FUNK.
CHAS. J. EWIN.

Subscribed in my presence, and sworn to before me, by the said William Kirby, Fred J. Funk and Charles Ewin, this 25th day of August, A.D. 1888.
BARRY MURPHY,
[SEAL.] *Notary Public in and for Montgomery County, Ohio.*

[Copy.]

CRESCENT BEACH, MASS., Aug. 21, 1888.

S. C. PECK, Boston, Mass.

SIR, — In working as lineman on the two Thomson-Houston Electric Roads along the beach, I have many times been subjected to the full pressure of the generator, often receiving the shock through my whole body. Besides a stinging sensation and often a blister, I have never been injured and have always kept right along with my work. Every one working on the road has taken these shocks and no one has yet been hurt.

We don't mind it much and certainly do not think it dangerous.

Yours truly,
WM. H. O'NEIL.

Subscribed and sworn to before me this 21st day of August, 1888.
JOHN H. PUTNAM, *Justice of the Peace.*

[Copy.]

CRESCENT BEACH, MASS. Aug. 21, 1888.

Mr. S. C. PECK:

I have been working as driver of the Thomson-Houston Electric Company's electric cars running at Ocean Pier, and have often taken the full force of the generator when running at 500 volts or over. I have never been hurt and do not think there is a bit of danger. It is not possible for a passenger to get a shock unless he gets at the motor which is put on the trucks under the floor. I have taken mine by standing on the ground and touching the commutator, which is in connection with the other pole of the dynamo.

Sincerely yours, JOHN MCFINGGAN.

REVERE, Aug. 21, 1888. Subscribed and sworn to before me,
JOHN H. PUTNAM, *Justice of the Peace.*

BIRMINGHAM, CONN., Feb. 26, 1889.

EUGENE GRIFFIN, ESQ., Gen'l Manager Ry's Department.

THOMSON-HOUSTON ELECTRIC COMPANY, Boston, Mass.:

DEAR SIR, — I have yours of the 25th, and will send by this evening's train, Mr. Porter, our superintendent, the Italian who got mixed up in the wire with his horses, and the contractor who had the Italian at work, and who himself helped extricate him. We can furnish you with a score of men who have had the full force of the current, we have had all manner of experiences with regard to the matter, and we have never had anything approaching a serious accident from this cause. Whatever fear of the current there was here at first among our men and the people generally, has entirely disappeared. If I can be of any further service to you, please do not hesi tate to call upon me.

Very truly,

(Signed) H. HOLTON WOOD, *President.*

STATE OF VIRGINIA, } ss.
TOWN OF DANVILLE, }

This day personally appeared before me, Eston Randolph, a Notary Public in and for the town and State aforesaid, W. W. Walker, who made the following statement under oath. "I am employed as an electrician in charge of the dynamo of the Danville Electric Street Car Company, am not connected with the Thomson-Houston Company. I have frequently received shocks by coming in contact with the apparatus in various ways when the full charge of 500 volts was on. Some of the shocks were very severe for a short time, but no permanent injury or inconvenience resulted."

Given under my hand this 22d day of February, 1889.

ESTON RANDOLPH, *Notary Public.*

STATE OF VIRGINIA, } ss.
TOWN OF DANVILLE, }

This day personally appeared before me, Eston Randolph, a Notary Public in and for said town and State, William West, who made the following statement upon oath. "I have received two severe shocks. The first time I was shocked it happened in this manner. I was standing with one foot on the ground and one on the turn-table. I took the iron crowbar in my bare hands and attempted to shove the car forward by putting the crowbar under the hind wheel of the car and pushing. Just at this time the current was turned on and I felt a severe shock. The second time I was standing on the wet ground and slipped and caught by the iron railing of the car which is within the circuit. This shock was more severe than the first one, but in neither case did I receive any special inconvenience or injury. I am an employe of the Danville Electric Street Car Company.

Given under my hand this 22d day of February, 1889.

ESTON RANDOLPH, *Notary Public.*

STATE OF PENNSYLVANIA, }
COUNTY OF LACKAWANNA, } SS.
CITY OF SCRANTON. }

George Sanderson being duly sworn according to law, deposes and says that he is a resident of the City of Scranton, County of Lackawanna and State of Pennsylvania and President of the Scranton Suburban Railway Company, a street railway company in said city, using electricity as a motive power, and that the voltage in use on said Railway is 500. Said Railway Company has been in existence over two years, and has always used electricity as a motive power. The employes of said Company frequently receive shocks from handling carelessly the electrical machinery and wires thereof, but there never has been a serious or fatal accident by so doing. Deponent himself on one occasion and under circumstances favorable for a complete connection — the day being rainy and the ground soaked with water — received the force of the current from the overhead wire, but aside from a severe shock, the effect of which was momentary only, and a slight burning of one of his fingers, did not experience the slightest discomfort from it.

GEORGE SANDERSON.

Sworn and subscribed to this 23d day of February, A. D. 1889.

H. B. REYNOLDS, *Notary Public.*

[Copy.]

STATE OF PENNSYLVANIA, }
COUNTY OF LACKAWANNA. } SS.

Personally appeared before me, an Alderman in and for the City of Scranton, State and County aforeraid, duly commissioned and qualified to administer oaths, &c., under the laws of said State — James Mitchell, who, being duly sworn, says that on several occasions, between the months of February and July, 1888, he received electrical shocks from circuit of 500 volts potential, without injury.

JAMES MITCHELL.

Sworn and subscribed to before me, this 24th day of August, A. D. 1888.

O. B. WRIGHT,
Alderman 9th Ward, Scranton, Pa.

[SEAL]

[Copy.]

STATE OF PENNSYLVANIA, } ss.
COUNTY OF LACKAWANNA. }

Personally appeared before me, an alderman in and for the City of Scranton, State and County aforesaid, duly commissioned and qualified under the laws of said State, to administer oaths, &c. &c., Torance Parrish, who, being duly sworn, said that during the last year he has on several different occasions, received an electrical shock from circuit of 500 volts potential, without any injury whatever.

TORRANCE PARRISH.

Sworn and subscribed before me this 25th day of August, A. D. 1888.

O. B. WRIGHT, *Alderman.*

[Copy.]

STATE OF PENNSYLVANIA, } ss.
COUNTY OF LACKAWANNA. }

Personally appeared before me the subscriber, an alderman in and for the City of Scranton, State and County aforesaid, duly qualified to administer oaths, &c., &c., under the laws of said State, &c., Frederic A. Hills, who, being duly sworn according to law, deposes and says: That on several occasions, between September, 1887, and August, A. D. 1888, he has received an electrical shock from circuit of 500 volts potential, with no injury, and further says not.

FREDERIC A. HILLS.

Sworn and subscribed before me this 24th day of August, 1888.

O. B. WRIGHT,
Alderman 9th Ward, Scranton, Pa.

[Copy.]

STATE OF PENNSYLVANIA, } ss.
COUNTY OF LACKAWANNA. }

Personally appeared before me the subscriber, an alderman in and for the City of Scranton, State and County aforesaid, duly commissioned and qualified under the laws of said State, to administer oaths, &c., &c., Harry D. Floyd, who being duly sworn according to law, deposes and says, that on the 22d day of July, 1888, at Crescent Beach, Mass, he received an electrical shock from circuit of 500 volts potential, with no injury whatever.

H. D. FLOYD.

Sworn and subscribed before me this 24th day of August, A. D. 1888.

O. B. WRIGHT,
Alderman 9th Ward, Scranton, Pa.

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